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FARMERS' BULLETINS

Nos. 1126-1150,

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WITH CONTENTS AND INDEX.

PREPARED UNDER THE SUPERVISION OF

JOHN L. COBBS, Jr.,
CHIEF, DIVISION OF PUBLICATIONS.

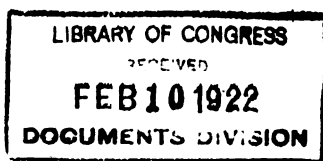


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SUDAN GRASS



SUDAN GRASS is grown for hay. It was obtained in 1909 from the Sudan Government at Khartum as the result of a systematic search for a form of Johnson grass without root-stocks. No other plant importation ever gained such immediate and widespread popularity in the United States.

Sudan grass is strictly an annual without underground root-stocks. It grows to a height of 3 to 5 feet in drilled seedings and 5 to 8 feet in cultivated rows. Drilled seedings are generally preferred for hay and the cultivated rows for seed production.

Sudan grass requires a warm climate for its best development and is of most value as an emergency hay crop, being superior to millet for this purpose in all except the northern third of the United States.

In irrigated sections of the Southwest, Sudan grass yields practically as much hay as alfalfa and is very useful in providing a variety of roughage for dairy cows.

The best time to cut Sudan grass for hay is when it is in full head, but the grass can be harvested somewhat earlier or later than this with no material loss in feeding value.

Sudan grass is a good soiling crop, but is of minor value for silage. The hay is equal in feeding value to that of timothy, millet, or Johnson grass.

It is being utilized more and more as a summer pasture in the Central and Southern States and is valuable as a pasture in the irrigated districts of the Southwest.

There is less danger of prussic-acid poisoning in pasturing or feeding Sudan grass than larger sorghums, but care must be observed in pasturing the grass, especially in the Northern States.

Feeding experiments have shown Sudan grass to be an excellent roughage for work animals and stock cattle and only slightly less valuable than alfalfa for milk cows.

Seed production is profitable only in certain favored localities. Johnson grass seed is dangerous as an adulterant in Sudan grass seed south of the thirty-eighth degree of latitude only. There Johnson grass behaves as a perennial and is difficult to eradicate.

Sudan grass hybridizes freely with the sorghums, and care is necessary to keep it from becoming a mongrel crop as have many of the sweet sorghums.

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief
Washington, D. C. May, 1920

SUDAN GRASS.

H. N. VINALL,

Agronomist, Office of Forage-Crop Investigations.

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ORIGIN OF SUDAN GRASS.

DOUBTLESS Johnson grass would be a much more valuable hay plant for the Southern States if it were not equipped with vigorous underground stems. Recognizing this fact, systematic search for forms of andropogons lacking these aggressive rootstocks was begun under the direction of C. V. Piper, Agrostologist in Charge of the Office of Forage-Crop Investigations. With the assistance of the Office of Foreign Seed and Plant Introduction, 8 ounces of seed of a grass known as Garawi was obtained on March 15, 1909, from Mr. R. Hewison, Director of Agriculture and Lands of the Sudan Government at Khartum.¹ A portion of this seed was planted at the Forage-Crop Field Station, Chillicothe, Tex., that spring. The grass proved very promising there, and it has since been grown at many other points. In order that it might have a distinctive name it was called Sudan grass.

DESCRIPTION OF SUDAN GRASS.

Under cultivation in the United States, Sudan grass has shown itself to be distinctly an annual. Only under practically frost-free conditions, such as obtain along the Gulf coast and in southern California, have plants lived over winter. This grass is very closely related to the cultivated sorghums and hybridizes with them readily. The fact that it has no rootstocks places it nearer the cultivated sorghums than Johnson grass, though for many years Johnson grass

¹ Piper, C. V. Sudan grass, a new drought-resistant hay plant. U. S. Dept. of Agr., Bur. Plant Indus. Cir. 125, 20 p. 1913.

Oakley, R. A. Some new grasses for the South. In Yearbook, Department of Agriculture, for 1912, p. 495-504.

has been credited by some botanists with being the primitive form of the sorghums.

Sudan grass when seeded broadcast or in drills grows about 3 to 5 feet high and has stems about three-sixteenths of an inch in diameter



FIG. 1.—Single plant of Sudan grass, illustrating its habits of growth when planted in rows.

(a little smaller than a lead pencil). If grown in rows and cultivated, it reaches a height of 6 to 8 feet, and the stems are about one-fourth of an inch in diameter. (Fig. 1.) The panicle is loose and open, very much like that of Johnson grass, but a little larger and a trifle less open. The hulls, or glumes, are awned and when in flower are often

purplish in color. This color usually fades to a pale yellow when ripe. The awns are broken off in thrashing, so that the commercial seeds



FIG. 2.—Young plants of Sudan grass (left) and Johnson grass (right), showing the vigorous rootstocks of Johnson grass and their entire absence on Sudan grass.

rarely have awns. The leaves are broader and more numerous than those of Johnson grass, giving the grass a much more favorable appearance as a hay plant. The most important difference, however,

is that the aggressive underground stems, or rootstocks, with which Johnson grass is equipped are entirely absent in Sudan grass. This striking difference is shown clearly in the accompanying figure illustrating young seedling plants of the two grasses. (Fig. 2.) Sudan grass, like the cultivated sorghums, never develops anything but fibrous roots, therefore it can not become an obnoxious weed as the perennial Johnson grass does. Furthermore, it has shown no tendency to persist in fields as an annual weed through volunteer seedings. When it has plenty of room, the grass tillers very freely. It is not uncommon to find over 100 stems arising from one crown. This decided tendency to tiller is most apparent after the first cutting, and usually makes the hay from the second cutting of finer texture than that from the first.

CLIMATIC REQUIREMENTS.

Sudan grass, like sorghums, does best in a warm climate. In favorable seasons, where the growing period is long, as many as four cuttings can be obtained in one year. As in the case of all other crops, in determining the regions of greatest importance, climatic and soil conditions are linked with the acuteness of the need for such a crop. The principal regions of production in the United States are shown on the map (fig. 3) as follows:

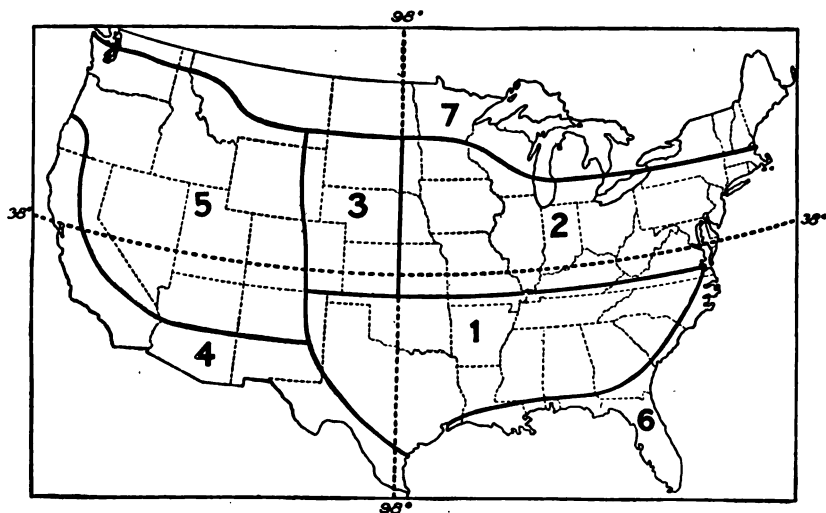


FIG. 3.—Outline map showing the forage value of Sudan grass in different parts of the United States.

Region 1.—Two or three good cuttings of hay are secured without irrigation in this region, the yields varying from 2 to 4 tons to the acre. This is the region of its greatest importance because of the need for a better hay grass in these States. Profitable seed yields are secured west of the 98th meridian only, the sorghum midge usually preventing seed formation in the more humid district east of this meridian.

Region 2.—Sudan grass thrives here almost as well as in region 1, making good yields both of hay and of seed. Timothy, clover, and alfalfa, however, meet the hay requirements of this region so fully that Sudan grass is valued chiefly as a catch crop or for limited culture on soils not suited to these forage crops.

Region 3.—This comprises the region west of region 2, where the rainfall is too low for the successful cultivation of timothy and clover. Sudan grass commonly makes one cutting under such conditions, and in favorable seasons two, yielding 1 to 3 tons of hay to the acre. Its chief competitors in this region are alfalfa, sorghum, and millet. Alfalfa is preferred to Sudan grass only in the more favored locations, such as river and creek valleys or where irrigation is possible. The better varieties of sorghum, such as Red Amber and Orange, will outyield Sudan grass, but the latter is better suited for pasture purposes, produces a better quality of hay, and is easier to handle with haying machinery. Seed production, though possible in most of this region, is profitable only in the southern part.

Region 4.—Sudan grass yields abundantly both in hay and in seed in all irrigated localities in this region; yields of 4 tons of hay to the acre are not uncommon on good soils. It is used chiefly to supplement alfalfa in the rations of horses and dairy cattle, as a pure alfalfa hay ration seems to result in digestive disturbances, especially in dairy cows.

Region 5.—In this part of the United States Sudan grass is successful only in limited areas. Its failure except in these localities is due either to low temperatures caused by high altitudes or to insufficient rainfall.

Region 6.—In this region, including Florida and the Coastal Plain along both the Atlantic and Gulf coasts, Sudan grass is usually a failure, largely on account of the injury to the foliage caused by red-spot or sorghum blight.

Region 7.—This is a region 100 to 200 miles wide along the northern border of the United States. Sudan grass is not profitable here, because of the cool summers and short growing season.

Since its introduction in 1909 Sudan grass has become known in nearly every part of the United States and is now being grown where it was at first thought to be wholly unadapted. Its short growing period permits it to thrive and make good crops of hay as far north as southern Michigan and New York. Throughout the timothy and clover region, though it may never become the leading hay grass, it will be used more and more as a catch crop in place of the millets. In the Rocky Mountain region (fig. 3, region 5) the results are for the most part unfavorable except in the irrigated valleys. At the higher altitudes untimely frosts and continued low temperatures during the summer months preclude a successful growth. The upper limits of profitable hay production seem to be 6,000 to 8,000 feet in New Mexico, Arizona, and southern California; 5,000 to 6,000 feet in Colorado, Utah, Nevada, and northern California; and 4,000 to 5,000 feet north of those States. The altitudinal limits for seed production are at least 1,000 feet lower, respectively, than those named for hay, because under cool conditions it takes a month or more to mature seed after the crop is ready to be cut for hay.

DROUGHT RELATIONS.

That Sudan grass will grow and produce fair crops in regions of low rainfall has been demonstrated by numerous tests in the Great

Plains. Its ability to endure periods of drought is equal, though not superior, to that of the best varieties of sorghum. In the South, where drought is usually combined with extreme heat, Sudan grass yields much better than millet, but in Montana and the Dakotas millet makes a slightly larger yield.

Experiments have shown that Sudan grass requires a greater amount of water to produce a pound of dry matter than does corn, sorghum, or millet. Notwithstanding this indicated high water requirement, Sudan grass has been successfully grown as a dry-land



FIG. 4.—A plat of Sudan grass (at left) grown beside a plat of Kursk millet at Redfield, S. Dak., 1916. Both crops are in approximately the right stage to be cut for hay.

crop since 1912, when the first wide distribution of seed took place. As an emergency hay crop and summer pasture no other crop is better suited to conditions in the southern half of the Great Plains.

On the University Farm at Davis, California, it has been grown with good results as a dry-land crop and is recommended for use in other parts of that State where irrigation water is not available.¹

SOIL REQUIREMENTS.

Sudan grass is not at all exacting in its soil requirements. It does best on a rich loam, but it has been grown successfully on almost every class of soil from a heavy clay to a light sand. Where the soil is quite sandy, however, the yield may be expected to be light. Cold, wet, muggy soils are particularly unsuited to Sudan grass. Before

¹ Madson, B. A., and Kennedy, P. B. Calif. Agr. Exp. Sta. Bul. 277, p. 200. 1917.

such soils will grow it, thorough drainage must be provided. Small amounts of alkali in the soil reduce the yields markedly and stronger concentrations prevent profitable culture.

PLACE IN THE CROPPING SYSTEM.

Although Sudan grass is an annual and can be introduced easily into any rotation, it probably never will be widely used as a staple crop in permanent rotations. To fill such a position acceptably a crop must serve either as a "money crop" or as a soil improver. Under certain conditions in the Southern States Sudan grass utilized as a hay crop or for seed production may be considered as a cash crop, but in most cases it will be grown as an emergency hay crop or for summer pasture.

The other two crops most widely grown as catch crops or emergency hay crops are millet and sorgo, or "cane." (Fig. 4.) The yields of Sudan grass, as compared with these two, its chief competitors, over a series of years from 1912 to 1916 and at a considerable number of stations are given in Table I.

TABLE I.—*Comparison of Sudan grass with millet and sorgo in yields per acre of cured hay.*

Regions.	Yield per acre (tons).		
	Sudan grass.	Millet.	Sorgo.
Northern Great Plains.....	2.28	2.14	3.89
Central Great Plains.....	2.51	2.01	3.49
Southern Great Plains.....	4.03	1.25	5.34
Timothy and clover belt.....	2.64	2.65	5.95

It will be seen that in the northern Great Plains and in the timothy and clover belt millet yields practically as much hay as Sudan grass, but in the central Great Plains there is a difference of one-half ton per acre in favor of Sudan grass, and in the southern Great Plains the yield of Sudan grass is over three times that of millet. The yield of sorgo in drilled or broadcasted seedings averages in each region about 1 ton more hay per acre than Sudan grass, but this is because of the larger amount of moisture in the sorgo hay due in a measure to the greater difficulty of curing its coarse stems. The difference in the actual yield of dry matter is partly offset by the better quality of the Sudan grass hay.

VALUE IN IRRIGATED REGIONS.

In many of the irrigated parts of the West, where alfalfa is the principal crop and dairying the chief industry of the people, alfalfa has been made the constant and the almost complete diet of the cows. The continuous use of this high-protein hay has caused digestive

troubles, but this derangement of the digestive functions seems to disappear promptly when the feed is changed. Under irrigation south of Oregon and Wyoming; Sudan grass makes an excellent crop to grow for mixing with alfalfa. Yields of cured hay obtained under irrigation in California and Arizona have been equal and in some cases larger than those from alfalfa. At Chico, Calif., Sudan grass when irrigated gave a yield of 9.8 tons of cured hay per acre, as compared with a yield of 8.3 tons of alfalfa hay; and at Bard, Calif., in the extreme southern end of the State, Sudan grass on favorable soil gave a yield of 8 tons of hay per acre, as compared with 7.9 tons of alfalfa. The yield of 8 tons at this place was obtained from grass planted almost a month later than it should have been. At Phoenix, Ariz., the yield of Sudan grass was 7.8 tons per acre, as compared with a yield of 9.8 tons of alfalfa, and at Owens, Ariz., Sudan grass made a yield of 4.5 tons per acre with only one irrigation during the season.

These unusual yields of hay from an annual crop, which by its nature can be made to fit into any rotation, will no doubt mean much to the dairying industry of the Southwest.

The percentage of moisture is apt to be somewhat greater in Sudan grass than in alfalfa when the weights are taken directly from the field, but less labor is necessary to handle the Sudan grass because the maximum yield from it is secured in three cuttings, while with the alfalfa five or more cuttings are required to produce the yields mentioned.

Sudan is the only grass which yields under irrigation in the Southwest even approximately as much as alfalfa. It can be used, therefore, in providing a change of feed without reducing the tonnage obtained from the land. Sudan grass was found just in time to fill this need, and although it is not as rich in protein as alfalfa, experience indicates that when mixed with alfalfa or fed with some concentrate rich in protein the flow of milk will be nearly or quite normal.

SUDAN GRASS AND LEGUME MIXTURES.

The suitability of Sudan grass for growing in mixtures with cowpeas, soy beans, and other legumes in regions to which Sudan grass and these legumes are well adapted is at once apparent. (1) Sudan grass grows strictly erect, with a stem stiff enough to support the vines characteristic of most legumes, and it thus makes the harvesting easier by keeping the legumes off the ground. It also allows them to cure more quickly by preventing the leaves from matting. (2) It is low in protein, which is abundant in the legumes, and thus a well-balanced mixture is produced. (3) The yields, although they are not often as great as when Sudan grass is seeded alone, are more valuable, as the feeding value of the hay is considerably enhanced.

The yields obtained from such a mixture in 1913 varied from 1 to 3½ tons per acre. The best showing was made at the Maryland Agricultural Experiment Station, where the yields averaged about 3½ tons of cured hay per acre. In 1912 at Arlington Farm, Virginia, the mixture of Sudan grass and cowpeas gave a yield of 4.6 tons of cured hay per acre, and Johnson grass in mixture with the same variety of cowpeas made a yield of only 2.8 tons per acre. (Fig. 5.)

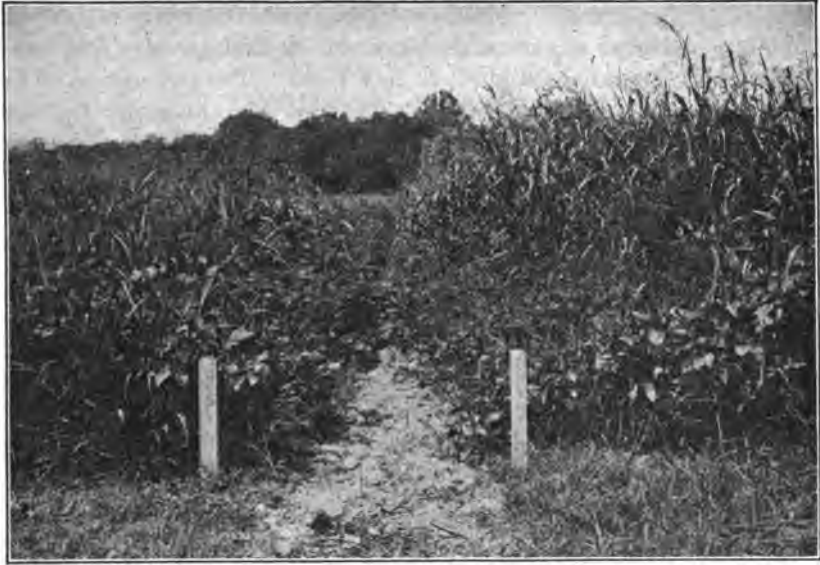


FIG. 5.—Plats at Arlington Farm, Va., in 1912, showing mixtures of Sudan grass and cowpeas (right) and Johnson grass and cowpeas (left).

Sudan grass in mixture with soy beans the same year yielded 4.4 tons per acre. Such mixtures are profitable only in humid regions or where irrigation is possible.

CULTURE.

PREPARATION OF THE SEED BED.

In seeding Sudan grass a rather firm seed bed is best. Usually, when it is desired to drill the seed, the ground is plowed in the spring and harrowed well, as for corn. A cool soil delays the germination of the seed; therefore spring plowing is preferable for the seed bed, because it assists in warming the soil. No fertilizers are necessary in the West, where the soil is reasonably good, but in the East it is probably advisable to use some complete fertilizer, such as is applied for corn, or some combination of phosphorus and nitrogen, if the price of potash is high. Few experiments have been conducted to determine the best practice to follow, but in Kentucky applications of acid phosphate at the rate of 200 pounds per acre resulted in increases of

yield in 8 out of 10 cases. The average increase attributed to the fertilizer was 68 per cent.

DATE OF SEEDING.

It has been found best to seed Sudan grass after the soil has become warm, or about two weeks after corn-planting time. When sown in cold soil the result usually is a poor stand or a slow growth for several months, so that in the end no advantage has accrued from the early seeding.

Widely scattered experiments have shown that in very few cases are the earliest seedings highest in hay yield. The experience so far gained by the United States Department of Agriculture in its tests indicates that for the extreme South the best time for seeding lies



FIG. 6.—A close-up view of a field of Sudan grass seeded with a grain drill on June 1. Photographed August 12, 1915, at Hays, Kans.

between April 1 and May 1; in the latitude of Oklahoma and Kansas, any time between May 1 and June 15 (fig. 6); and in the latitude of Nebraska and South Dakota between May 15 and June 15. From Kansas south good crops of hay can be secured from seedings made July 1 or even later.

METHOD OF SEEDING.

For hay production in regions of abundant rainfall the best machine for seeding is no doubt the common grain drill. Well-cleaned seed feeds freely from this drill, and it can be distributed evenly and a good stand thus secured. If a press drill is used the ground is left level and in good condition for the mower. The depth of seeding has but little effect on the root system of Sudan grass. It seems to be a characteristic of the grass that the root system begins near the surface

of the soil, regardless of the depth at which the seed is placed. The best depth, everything considered, is about 1 inch, but where the soil does not become packed the plant will force itself to the surface even from a depth of $3\frac{1}{2}$ to 4 inches.

In the semiarid regions for hay, and in any locality for seed production, better results are obtained by seeding in rows far enough apart to allow cultivation. This can be accomplished with a grain drill by stopping up a sufficient number of the holes so that the rows will be the desired distance apart. If only the ordinary corn cultivators are available for the work it is best to place the rows 36 to 42

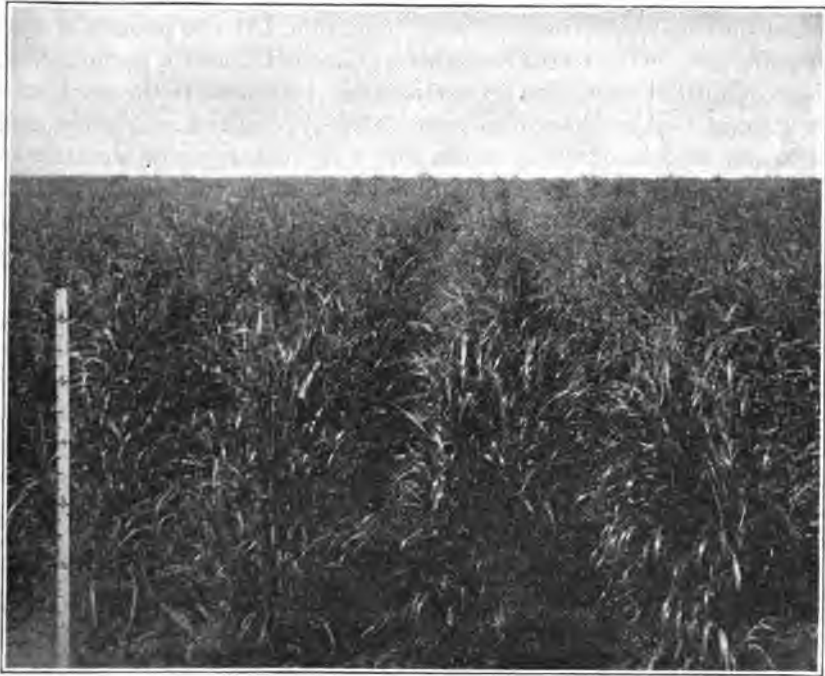


FIG. 7.—Sudan grass planted in rows 42 inches apart for seed production. Photographed at Hays, Kans., September 9, 1915.

inches apart. (Fig. 7.) If a beet cultivator or some similar tool is available, larger yields can be obtained from rows 18 to 24 inches apart. Twenty-four inches is perhaps as close as practicable, unless horses especially trained to walk between the rows are to be had. Otherwise much of the stand will be destroyed by trampling in rows less than 24 inches apart. Against any difference in favor of the cultivated-row planting over the broadcasted field will have to be charged the cost of cultivation. A better quality of hay is produced from the broadcast stand, owing to the finer stems. The grass grown in cultivated rows is likely to be coarse and therefore not so desirable for market hay. For home feeding the coarseness will be of little dis-

advantage, as the stems do not become so woody that they are refused by stock.

RATE OF SEEDING.

Rates of 10 to 40 pounds of seed to the acre have been tested at the different agricultural experiment stations. There was, however, no definite superiority indicated for any one of these rates in drilled seedings. Sudan grass tillers so profusely in thin stands that the final number of stems per square foot of ground is usually very nearly the same, whether the rate is 15 or 40 pounds. Taking all the factors into consideration, 20 to 25 pounds per acre are recommended for drilled or broadcasted seedings in the humid regions and 12 to 15 pounds in the dry sections. Under irrigation, 15 to 20 pounds of seed are sufficient, owing to the more favorable conditions for germination. These quantities should be proportionately increased if the seed is of low germination or the soil in poor physical condition. A grain drill set to sow 2 pecks of wheat to the acre will ordinarily sow about 20 to 25 pounds of Sudan grass seed. If it is desired to sow a less quantity, this can be accomplished by stopping alternate holes in the drill or by mixing the Sudan grass seed with bran or some other mill feed in any proportion necessary.

For seeding in cultivated rows 36 to 44 inches apart, 2 to 4 pounds of seed per acre will be found sufficient, while in rows 18 to 24 inches apart, 4 to 6 pounds per acre will be required, the smaller quantity being used, as in the broadcast seedings, for regions of light rainfall. If the crop is intended for hay, enough seed should be used in any case to insure a thick stand of plants in the row. When a seed crop is desired, the rate of seeding should ordinarily be somewhat less than for a hay crop.

HARVESTING.

The most common way of harvesting the grass for hay is with a mower. It cures readily and can be cut in the morning and if the sun is bright raked up that afternoon or the next day. After bunching, it is placed in cocks, just as with millet, and removed from these cocks to the barn or stacks after it has thoroughly cured. Because of the large amount of juice in the stems of Sudan grass, the leaves cure first and the hay often appears ready to stack when it is not; therefore, the only sure way to avoid injury by heating is to allow Sudan grass to remain in cocks long enough for the stems to become dry. The leaves are retained well, and if cut at the right stage of maturity and handled properly it will make a bright, leafy, sweet hay of the very best quality.

Where the crop is desired for seed, it is harvested like the small grains with an ordinary grain binder and allowed to cure in shocks. This method can also be used in making hay in the semiarid regions where such good drying weather prevails that the grass will cure in

the shock. Where the planting is made in cultivated rows, a corn or row binder can be used, but in most cases a grain binder is preferable. Sometimes, where the growth is rank, trouble is experienced in getting the reel over the tops of the plants and at the same time cutting a short stubble.

The time for cutting is governed to some extent by the fact that several cuttings are expected in most cases, and this often makes it seem more profitable to cut the first time as early as possible, so that the grass will have more time for the second growth. Experiments have shown, however, that early cutting is not justifiable either from the standpoint of total yield or from that of food value. At the Fort Hays experiment station, Hays, Kans., the average seasonal yield of air-dry hay for the years 1915 to 1918, inclusive, was as follows:

	Tons per acre.
1. Cut just before heading.....	1. 83
2. Cut as the first heads appeared.....	2. 24
3. Cut when in full head.....	2. 14
4. Cut when the seed was in milk.....	2. 31

In the first stage two cuttings were obtained each year; in the second stage in three out of four years; and in the third stage in only two of the years. In the fourth stage only one cutting a year was obtained, but the average yield was the largest of the four methods.

The above experiment clearly shows that it is not profitable to cut Sudan grass before it has begun to head. The preferable stage of maturity for cutting is from the time it begins heading until it is fully headed. There is little loss, however, when the grass is allowed to grow until the seed has reached the soft dough stage and only one cutting is then required to harvest the crop and obtain a maximum yield of forage.

There are very few hay grasses which are injured so little by standing beyond the proper stage of maturity as Sudan grass. This is due largely to the numerous tillers which, arising from the base, mature successively later than the primary stem and provide immature stalks throughout the entire growing season. There is, in addition, the fact that like the sorghums it holds its leaves well and makes the best quality of fodder when the seed has reached the dough stage. This characteristic makes it possible, where necessary, to extend the haying process over a long period without any material loss either in the quantity or quality of the hay. Such a feature is of great importance to the farmer, since haying is often interfered with by other work or by rains which prevent cutting at the most favorable time.

The scarcity of roughage, the presence of a drought, or the danger of loss from insects may also enter into the decision as to when Sudan grass should be harvested. If feed is scarce, or the weather turns dry,

or grasshoppers become destructive, a good crop of hay can be harvested in 50 to 55 days from the date of seeding; and even though the grass has not then reached the proper stage of maturity for cutting, it should under such conditions be harvested.

UTILIZATION.

HAY.

The hay from Sudan grass is of excellent quality and the yields are quite satisfactory; therefore, the grass will continue to be most largely



FIG. 8.—Bundles of Sudan grass, illustrating its rapidity of growth. From left to right: No. 1, 71 days; No. 2, 56 days; No. 3, 42 days; No. 4, 28 days; and No. 5, 13 days from date of seeding. Sudan grass should not be cut for hay until it has reached the stage of maturity shown by bundles 1 and 2.

utilized as a hay crop. From the central United States southward it is possible to get two cuttings, and in favorable instances as many as four cuttings have been secured. From seeding to the first cutting 60 to 80 days are necessary. When conditions favor continuous growth the second cutting is ready in about 45 days after the first one, but the third one is likely to take a little longer—50 to 55 days. (Fig. 8.) This means that the growing season must extend over a period of six months to produce three cuttings. By cutting the grass

a little earlier each time, four cuttings can be obtained during the same period. This was done at Chillicothe, Tex., in 1912. A plat was seeded April 26 and the following cuttings obtained:

Date of cutting.	Yield per acre.	Growing period.
	<i>Pounds.</i>	<i>Days.</i>
June 22.....	2,140	57
July 17.....	1,810	25
August 20.....	3,050	34
October 14.....	1,800	55
Total.....	8,800	171

It is quite probable that an equally large yield of hay of better quality would have been obtained from three cuttings, as this would have given time for each cutting to reach the proper stage of maturity.

It will be noted in Table I that Sudan grass can be expected to make an average yield of 2½ tons in the Northern and Central States and about 4 tons of hay per acre in the Southern States. These yields were obtained without irrigation. When irrigated, the yields compare favorably with those of alfalfa. In a few localities millet has given a slightly larger crop than Sudan grass, but comparisons between the two crops in such cases have been based on one cutting only. When the very much better quality of the Sudan grass hay and the possibility of two or more cuttings in the Southern States are taken into account there is little doubt that this grass will replace millet as the most widely used catch crop.

SOILING AND SILAGE.

Sudan grass is admirably suited for use as a soiling crop, since it makes a large yield and is very palatable in the green state. By this method of feeding, a small area in the South, where the rainfall is adequate or where irrigation is possible, can be made to support a goodly number of animals. Large yields are secured under irrigation, because the growth is so rapid and the recovery from cutting so prompt.

The use of Sudan grass for silage will no doubt be limited, owing to the ease with which it can be made into hay, to the fact that there is but little waste in feeding it as hay, and to the larger silage yields of the sorghums and corn. The Oklahoma experiment station¹ has conducted some experiments with Sudan grass silage. A considerable number of analyses were made which showed that Sudan grass silage was about the same in chemical composition as corn silage. Sheep did not relish the silage as well as they did corn silage, but they liked it equally as well as they did the silage made from grain sorghums.

¹Francis, C. K., and Friedemann, W. G. Okla. Agr. Exp. Sta. Bul. 115, 8 p. 1917.

Mixtures of Sudan grass with cowpeas or soy beans can be grown for silage in humid regions. Such mixture makes a bright-colored, palatable silage of high feeding value.

PASTURE.

Sudan grass is rapidly gaining popularity as a summer pasture crop. In regions of low rainfall and high temperatures, its carrying capacity during the hot summer months is superior to that of any other grass or legume. On the experimental farm at Dodge City, Kans., in the summer of 1914 a herd of milk cows was pastured alternately on Sudan grass and on native grasses. The Sudan grass furnished abundant pasturage at the rate of one cow per acre for 125 days and the cows made a daily average of 3.8 pounds more milk per cow on the Sudan grass than on the native grasses.

In 1915, at Chillicothe, Tex., mules, horses, and cows allowed the run of a field containing equal areas of Amber sorgo, Golden millet, and Sudan grass all showed a decided preference for the Sudan grass. At the Arizona experiment farm near Prescott, Ariz., Sudan grass without irrigation maintained 20 sheep per acre continuously for 100 days. The sheep pastured on Sudan grass fattened, while those grazing Amber sorgo made only ordinary growth. The California experiment station pastured a nonirrigated field of Sudan grass with sheep at the rate of 22 head per acre. The sheep made gains of one-third of a pound a day while on the pasture, and no injurious effects were noted.

Sudan grass is also one of the best pasture grasses for irrigated lands in the Southwest. On the Yuma experiment farm at Bard, Calif., a small area of about 8 acres was pastured for six months in 1915 with milk cows and work horses (fig. 9). The field was divided in halves and each half pastured alternately in periods of 2 to 3 weeks. The grass was irrigated in each case as soon as the animals were removed. The field maintained an average of three head per acre in good condition throughout the entire period.

Besides these more or less definite tests by experiment stations, numerous farmers have reported excellent results with Sudan grass pasture. Hogs relish the grass and when they have access to Sudan grass pasture, good gains can be produced with one-half the customary grain ration.

Sudan grass, like Johnson grass, is less likely to contain dangerous amounts of prussic acid than the larger sorghums. Only three authentic cases of poisoning by Sudan grass have been called to the attention of the United States Department of Agriculture. The most serious of these occurred on a farm in Kansas where for two years Sudan grass had been pastured without trouble. The third year, after a crop badly injured by drought had been cut for hay, 40 cows were turned into the field to pasture the aftermath. In three hours

17 of the cows became sick and some of them died. Such experiences show plainly that, notwithstanding the comparative safety of Sudan grass as pasture, care must be used in pasturing it with cattle, especially in the Northern States.

Several facts in regard to prussic-acid poisoning should be kept in mind by the grower of Sudan grass.

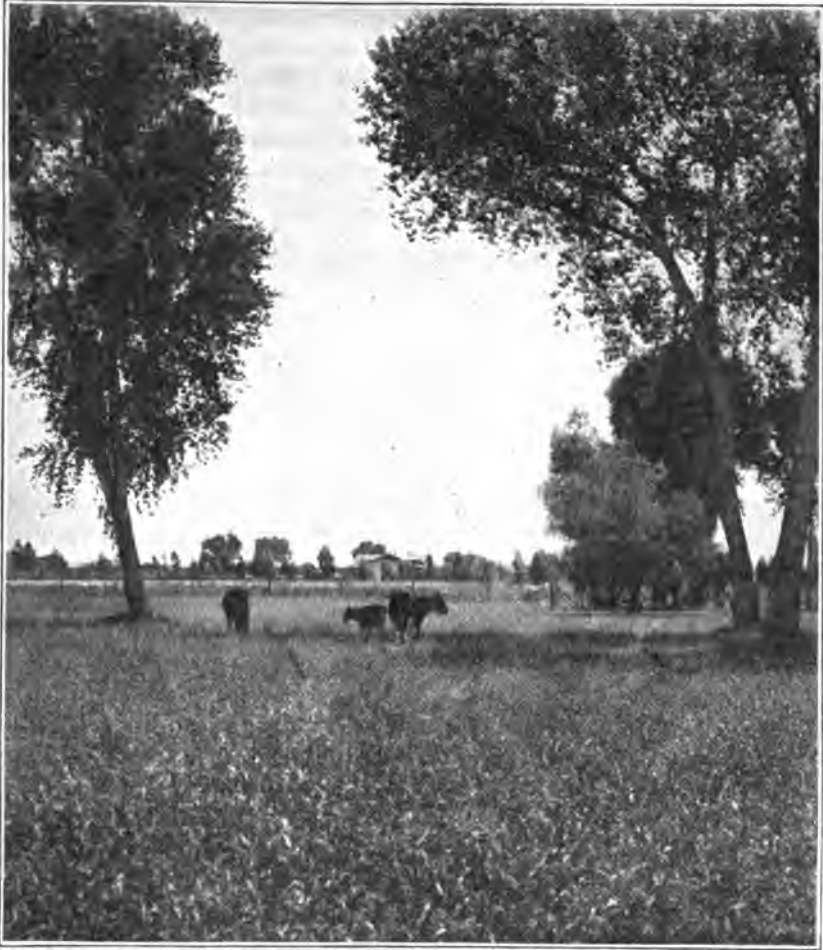


FIG. 9.—Cows pasturing on irrigated Sudan grass at Bard, Calif.

(1) The formation of prussic acid is most frequent in Sudan grass that has been injured by drought or other unfavorable climatic conditions.

(2) Hogs can be pastured on Sudan grass in safety, and horses and sheep are less susceptible to the poison than cattle.

(3) No case of Sudan grass poisoning has been reported from the Southern States. North of Oklahoma care must be exercised in pasturing Sudan grass with cattle.

(4) The poison acts quickly and no sure remedy for it has been found. Doses of glucose or other sweet sirups relieve the animal in some cases. Soda and dilute vinegar used as a drench while the mixture is foaming has also been recommended.

FEEDING VALUE.

Sudan grass is relished by all classes of live stock either as a hay or when fed green. Chemical analyses of Sudan grass show it to have about the same composition as the common foxtail millet and timothy.

TABLE II.—*Total nutrients and amount of each digestible in 100 pounds of the dry matter of Sudan grass, millet, and timothy.*¹

Nutrients.	Total.			Digestible.		
	Sudan grass.	Millet.	Timothy.	Sudan grass.	Millet.	Timothy.
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
Dry matter	100	100	100	63.50	65.00	59.00
Ash	7.94	7.35	5.23	.....	.....	.....
Ether extract	1.80	3.27	2.98	.....	2.09	1.42
Protein	8.96	9.63	7.34	3.89	5.81	4.33
Crude fiber	29.63	28.00	33.83	20.56	19.04	19.28
Nitrogen-free extract	51.62	51.69	50.69	34.22	34.63	31.93

¹ The averages of 35 analyses of Sudan grass made by the Bureau of Chemistry, United States Department of Agriculture, are given in Table II, together with the averages of 56 analyses of common or Hungarian millet, and 50 analyses of timothy. The analyses of millet and timothy are taken from Henry and Morrison's Feeds and Feeding, 16th edition, as were also the coefficients of digestibility used in calculating the pounds of digestible nutrients in each 100 pounds of dry matter. The amounts of digestible nutrients in Sudan grass were calculated from coefficients given in Table XIII of Iowa Experiment Station Research Bulletin No. 46, p. 73. These coefficients are the averages of those obtained by the Maryland experiment station and the Iowa experiment station.

It appears from the results in Table II that Sudan grass is slightly less digestible than millet, although more digestible than timothy. Sudan grass grown in the dry atmosphere of the Western States has a higher protein and ash content than that grown in the more humid climate of the Central and Eastern States. Plants grown in the East and cut when in bloom showed 5.85 per cent of crude protein and 5.48 per cent of ash, and those grown in the West and cut at the same stage of maturity had 9.62 per cent of protein and 8.9 per cent of ash. This difference in composition appears to be sufficient to affect the feeding value of the hay.

Feeding experiments conducted by the agricultural experiment stations at Manhattan and Hays, Kans., show that Sudan grass has a somewhat higher feeding value than a consideration of the chemical analyses indicated. In the winter of 1914-15 a test was conducted at the Fort Hays experiment station in wintering horses and mules on Sudan grass. The horses and mules were taken from a normal grain ration when work ceased and placed on a ration consisting wholly of roughage. One lot, consisting of four horses and two mules, was fed 20 pounds of Sudan grass hay per head daily, a second lot of the same kind and number of animals was fed a daily ration of 20 pounds per head of alfalfa hay, and a third lot was fed 20 pounds of kafir stover per head daily. At the end of a 50-day feeding period the lot fed on Sudan grass had lost an average of only 8 pounds per

animal, the lot fed on alfalfa showed an average gain of 5 pounds per animal, and the lot fed on kafir stover showed an average loss of 50 pounds per head.

The Fort Hays experiment station also found Sudan grass hay an efficient feed for carrying stock cattle through the winter. When fed with a small supplementary ration of silage and linseed or cottonseed meal, steady gains in weight were obtained during the winter at a reasonable cost.

For milk cows Sudan grass hay was slightly less efficient than alfalfa in a test carried out at the Kansas experiment station. Cows fed on Sudan grass hay with a supplementary ration of silage and grain produced 97 per cent as much milk as when fed alfalfa hay in place of the Sudan grass hay.

SEED PRODUCTION.

Sudan grass produces seed freely in a loose, open panicle which is held nearly erect by the stem, and can be harvested easily. The seed is retained fairly well, and thus the loss from shattering is much less than in other wild forms of sorghum. However, on the Great Plains, high winds sometimes shatter out a large percentage of the seed.

At the present time most of the commercial Sudan grass seed is produced in Texas, Oklahoma, and Kansas, but western Missouri and eastern Colorado and New Mexico also produce more seed than is needed for local consumption. Seed yields per acre are largest in the irrigated regions of California and Arizona, but only limited acreages are devoted to Sudan grass in these localities because of the profitable returns from other crops. The yields of seed per acre obtained in different sections of the United States are shown in Table III.

TABLE III.—*Yields of Sudan grass seed under different climatic conditions in cultivated rows and close drills.*

Climatic conditions.	Yield of seed per acre (pounds).			Number of localities. ¹
	Broadcast or close drills.	Cultivated rows 18 to 24 inches apart.	Cultivated rows 36 to 44 inches apart.	
Humid.....	328	417	354	10
Dry (not irrigated).....	224	296	270	13
Dry (irrigated).....	1,426	1,216	1,110	6

¹ The yields for the humid regions are averages for tests at Manhattan, Kans.; Stillwater, Okla.; Beeville and Temple, Tex.; Jackson, Tenn.; St. Paul, Minn.; Madison, Wis.; College Park, Md.; and Arlington Farm and Blacksburg, Va.; for dry regions not irrigated, averages of tests at Colby, Hays, Tribune, Garden City, and Dodge City, Kans.; Chillicothe, Spur, Lubbock, Amarillo, and Dalhart, Tex.; Ritzville and Wenatchee, Wash.; and Davis, Calif.; for dry regions irrigated, averages of tests at San Antonio, Tex., Phoenix, Ariz.; Bard, Davis, and Chico, Calif.; and Umatilla, Oreg.

These yields represent rather accurately the possibilities of seed production in different parts of the United States. Of course, certain localities are better suited to seed production than others. In Lubbock, Crosby, Floyd, Hale, and Swisher Counties in Texas the seed yields average about 600 pounds per acre for Sudan grass planted in rows, as compared with an average for the entire nonirrigated lands in the dry regions of only 270 pounds per acre. After the market demands for Sudan grass seed become better established, the seed production will no doubt be centered in favored localities, as it now is for such crops as Kentucky bluegrass, timothy, orchard grass, vetch, and alfalfa.

The planting of Sudan grass for seed production has already been described. Harvesting the seed is accomplished most economically with an ordinary grain binder or a row binder. Harvesting with a row binder is illustrated on the title-page. When the seed is practically mature, Sudan grass can be cut and bound like grain and left to cure in shocks. It may then be hauled directly to the thrashing machine or stacked in the same manner as bundle grain. There is danger in stacking Sudan grass, however, because the sap in the stems dries out slowly, and if stacked before it has cured thoroughly the grass will heat in the stack and injure the viability of the seed. Growers usually find it best, therefore, to allow the Sudan grass to remain in the shock until they are ready to thrash. The use of shock covers results in a much brighter, better quality of seed.

The ordinary grain separator thrashes and cleans Sudan grass seed very satisfactorily. Care must be observed to so regulate the air blast as to prevent seed from being blown over into the straw pile. A clover huller also has been used with success in thrashing Sudan grass, but seed thrashed in a clover huller is likely to be rather completely freed from the hulls and therefore weigh much heavier than ordinary seed.

The weight of the seed varies from 25 to 40 pounds per bushel. Good clean seed should weigh 36 to 40 pounds to the bushel, and such seed will pass through the feed of an ordinary grain drill without clogging.

Owing to the unusual success with Sudan grass in 1912 and 1913, the price of seed was high during the winter of 1913-14. Retail seed merchants asked \$1.50 to \$2 a pound for the seed, and farmers were paid 50 cents to \$1.50 a pound for seed in bulk. The retail price of Sudan grass seed for the last two or three years has varied from 12 to 20 cents a pound, and farmers have sold their supply at 10 to 15 cents a pound. It can be grown profitably at these prices, especially if the grower utilizes the thrashed Sudan grass as forage for his live stock

The seed of Sudan grass resembles Johnson grass seed very closely, except that it is larger and more plump. (Fig. 10.) No machinery for separating the two kinds of seed has been devised; hence the only way of obtaining pure Sudan grass seed is to guard against its mixture with Johnson grass during the growing period and in the thrashing process. South of 38° north latitude, indicated on the map shown as figure 3, Johnson grass behaves as a perennial and is troublesome because it is difficult to eradicate. North of the thirty-eighth parallel of latitude, roughly speaking, Johnson grass is not troublesome, because it usually is killed by the winter freezes. A slight admixture of Johnson grass in the Sudan grass seed sown for hay production north of the thirty-eighth parallel is no great disadvantage.

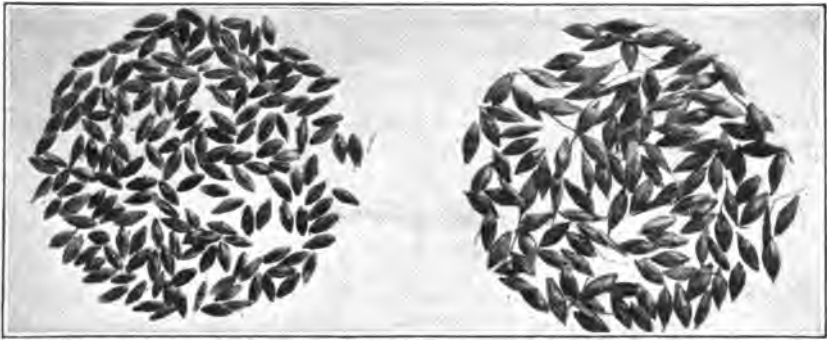


FIG. 10.—Seeds of Johnson grass (left) and Sudan grass (right) showing their comparative size and their similarity in shape.

South of this line, where Johnson grass is likely to become a pest, care must be used to see that the Sudan grass seed is free from Johnson grass seed.

The following suggestions may be remembered with advantage by the farmer in the Southern States: A farmer may grow sufficient seed for his own plantings and thus be assured of its purity; when he finds it necessary to buy Sudan grass seed and his land is free from Johnson grass, he should purchase only that grown outside the Johnson grass region or from responsible growers in the South who can guarantee the purity of the seed. If the Sudan grass is to be seeded on land already containing Johnson grass, the presence of seed of the latter is a matter of small importance.

The presence of even a small number of Johnson grass seeds can be detected by a properly trained seed analyst. A method for their identification has been formulated by F. H. Hillman, of the United States Department of Agriculture, and is described fully in Department Bulletin 406.

A point to be remembered in the production of Sudan grass seed is that the plant hybridizes very freely with sorghum, especially with

the sweet sorghums. In dry regions where the pollen is carried for considerable distances by the wind, a Sudan grass field intended for a seed crop should be 60 to 80 rods from any sorghum. Another source of cross-pollination exists in the volunteer plants of sorghum sometimes found in fields that were planted to sorghum the previous year. To avoid such sources of trouble, fields that have been growing other crops than sorghum should be chosen for the Sudan grass seed crop.

To make sure of pure seed, roguing the field at least once a year must be resorted to, and the rogues should be removed before a chance has been afforded for cross-pollination. The great need of special efforts to keep Sudan grass pure is illustrated by the present condition of the sweet sorghums, very few fields of which are to be found anywhere that are pure as to variety. They are very commonly mixed not only with other varieties of sorgho, but also with the grain sorghums. Unless seedsmen and growers unite in an effort to keep their seed fields free from sorghum hybrids, Sudan grass will lose much of its distinctiveness within the next 20 years.

DISEASES OF SUDAN GRASS.

RED-SPOT.

The worst disease of Sudan grass is the so-called sorghum blight,¹ more appropriately designated as red-spot. This is a bacterial disease, characterized by the appearance of distinct reddish spots on the leaves, which gradually spread until the leaves turn brown and die. (Fig. 11.) Its effect on the plant is much the same as rust, and, like rust, it is most destructive in warm, humid regions. It is prevalent in the Great Plains, but does little damage there except in wet seasons. Along the South Atlantic and Gulf coasts it almost entirely prevents the profitable production of Sudan grass. (See map, fig. 3.)

No remedy or preventive of red-spot has been found other than the use of resistant varieties. Rotation with other crops not subject to the disease probably holds it in check. In localities where sorghums are regularly grown, however, they furnish a continuous source of infection.

KERNEL SMUT.

Sudan grass is subject to the kernel smut of sorghum. This disease changes the individual kernels into a mass of dark spores covered by a grayish membrane. These spore masses look like an elongated seed, fully twice as large as the healthy kernels.

¹ Kellerman, W. A., and Swingle, W. T. Sorghum blight. In 1st Ann. Rpt., Kans. Agr. Exp. Sta., 1888, p. 281-302. 1889.

Burrill, T. J. A disease of broom-corn and sorghum. In Proc. 8th Ann. Soc. Prom. Agr. Sci., 1887, p. 30-36. 1887.

Radals, Maxime. On the blight of sorghum. In Bot. Gaz., vol. 28, no. 1, p. 65-68. 1899.



FIG. 11.—A Sudan grass plant affected with red-spot. Note the spots on the leaves. This illustration shows one of the earlier stages of the disease in which the vitality of the grass has not yet been overcome.

As in the case of red-spot, the sorghums furnish a source of infection for the kernel smut. This disease of the seed is not of any great importance in the production of Sudan grass for hay and pasture.

Kernel smut can be controlled very effectively by treating the seed with formalin.¹ One pound of full-strength formalin is mixed with 30 gallons of water. The sacks of seed are immersed for one hour in this solution, which should be stirred occasionally. Then the sacks are taken out and drained, after which the seed is spread upon a clean floor or canvas to dry. When dry the seed can be sown, but care must be used to see that, after the treatment, it does not come in contact with any smut-infected sacks. Such seed treatment is profitable only for planting fields intended for seed production.

INSECT ENEMIES OF SUDAN GRASS.²

GRASSHOPPERS.

In parts of the United States where grasshoppers are abundant they do considerable damage to Sudan grass. These grasshoppers are chiefly native species which hatch out in the vicinity. The cultivation of fields and fence rows late in the fall or in early winter destroys large quantities of the eggs and helps to keep these pests in check. The most effective method of controlling the grasshopper is by poisoned bran mash. This poisoned mash is made up as follows:

Bran.....	pounds..	25
Paris green or white arsenic.....	do....,	1
Molasses.....	quarts..	2
Oranges or lemons.....	number..	3
Water.....	gallons..	3½

The Paris green and bran are thoroughly mixed dry in some receptacle, such as a washtub. The juice of the oranges or lemons is squeezed into the water, the pulp and peeling chopped fine and added, after which some strong-smelling molasses is dissolved in the water, and the poisoned bran is moistened with this solution.

Early in the morning is the best time to scatter this damp mash about fields where the grasshoppers are troublesome. The quantity described in the foregoing formula is sufficient for 4 or 5 acres.

CHINCH BUG.

The chinch bug, though not as frequently troublesome as the grasshopper, does considerable damage when it is abundant. A field of Sudan grass can be protected from a threatened invasion of chinch bugs by means of a deep furrow plowed around the edges of the field,

¹ Freeman, E. M., and Umberger, H. J. C. The smuts of sorghum. U. S. Dept. Agr., Bur. Plant Indus. Cir. 8, 9. p. 1910.

² This discussion of insects was prepared with the advice and cooperation of W. R. Walton, entomologist in charge, cereal and forage insect investigations, Bureau of Entomology, United States Department of Agriculture.

the land side of the plow being toward the field. Holes with perpendicular sides are then dug across the bottom of the ditch at intervals of 30 to 40 feet. The chinch bugs in attempting to cross this furrow collect in the holes and can be destroyed by an application of kerosene oil.

Chinch bugs commonly pass the winter at the base of bunches of grass and in the piles of trash usually found along fences and hedge rows. Burning this grass and trash in November or December destroys a large percentage of the chinch bugs and does much to prevent trouble from them the following summer.¹

SORGHUM MIDGE.

This insect is destructive only in the South. It very largely prevents the profitable production of Sudan grass seed from central Texas east to the Atlantic coast. The damage to the plant is slight, other than the prevention of seed formation; therefore there is little loss from a forage standpoint.

There is no effective way of combating the sorghum midge other than planting very early or very late in the season, so that the Sudan grass will come into bloom at a time when the midge is not abundant.

IMPROVEMENT OF SUDAN GRASS.

Considerable work has been done at agricultural experiment stations in an effort to improve the original Sudan grass. No strains of exceptional value, however, have been developed, and in fact the grass as it came from Africa is a satisfactory hay and pasture plant. The chief need for improvement seems to be the production of strains of Sudan grass or hybrids between it and other grass sorghums which will be more resistant to red-spot.

¹ Webster, F. M. The chinch bug. U. S. Dept. Agr., Farmers' Bul. 657, 28 p., 8 fig. 1915.

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Farmers' Bulletin-1127
United States Department of Agriculture

PEANUT GROWING FOR PROFIT



PEANUTS have become one of the best money crops for use in rotation with cotton and other farm crops in the fight against the boll weevil. Until recently peanuts were grown in the greater part of the Gulf coast region primarily for stock feeding, but now they are of commercial importance in no less than 12 Southern States.

Good seed, proper preparation of the soil, frequent cultivation of the crop, proper harvesting and curing, and grading the product according to standard grades are the main essentials to the realization of a profit from peanuts. Most failures have been due to the neglect of one or more of the above essentials. Many losses have resulted from the practice of windrowing the peanut vines for curing instead of stacking them around small poles.

Peanuts are in increasing demand for oil manufacture and for making many other peanut products. It is always safe for the Southern farmer to grow peanuts, as every part of the crop can be used to advantage for feeding on the farm in case the market does not justify their sale. A closer working relation between growers and dealers is desirable, and the establishment of standard grades will do much toward stabilizing the industry.

Contribution from the Bureau of Plant Industry

WM. A. TAYLOR, Chief

Washington, D. C.

July, 1920

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PEANUT GROWING FOR PROFIT.

W. R. BEATTIE, *Horticulturist,*
Office of Horticultural and Pomological Investigations.

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CONDITIONS NECESSARY FOR PEANUT GROWING.

PEAUNTS are at present an important money crop in no less than 12 of the Southern States, especially in those regions infested by the cotton boll weevil. The peanut is a native of the Tropics and was introduced into the United States during the earlier days of colonization but did not become of commercial importance until about 1870. From that time until 1897 its importance as a farm crop was relatively small, but the production and uses of peanuts have increased enormously during the past 20 years. In 1918 the peanut crop of the United States was approximately 53,000,000 bushels, valued at about \$100,000,000.

The peanut is a pea rather than a nut and belongs to the same group of plants as do beans and common garden peas, differing only in that it possesses the character of blooming above ground and maturing its fruit, or pod, beneath the surface of the soil. The small yellow flowers are borne at the joints where the leaves are attached to the stems, and as soon as pollination takes place the flower fades and the "peg," as it is commonly called, elongates and goes into the soil, where the pod develops. Hence, it is essential that the crop be grown on soil where a loose surface can be maintained.

Peanuts will adapt themselves to a wider range of climate if soil conditions are favorable than almost any other southern crop. The climatic requirements of the peanut are a season of 100 to 140

days without frost, moderate rainfall during the growing period, an abundance of sunshine, and a relatively high temperature. Best results are secured under conditions where the normal annual rainfall is from 42 to 54 inches. Peanuts are frequently grown under irrigation. However, fair yields have been made without irrigation where the annual rainfall is less than 19 inches. On the other hand, good crops have been produced on low bottom lands with 54 to 60 inches of rainfall.

Light sandy loam soil is best adapted to the production of peanuts for the market. Poorly drained or sour soils are not generally desirable. For hog feeding or as forage the crop may be grown on almost any type of soil except the "black-waxy" and extremely heavy clays.

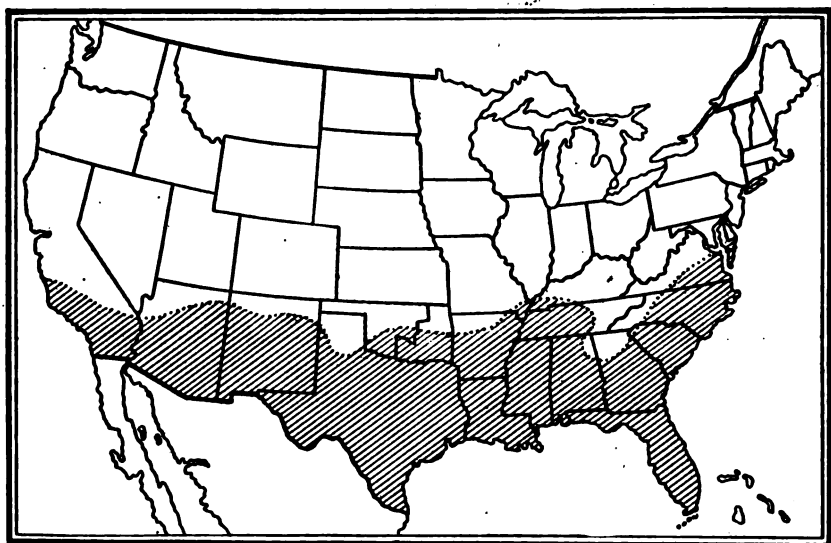


FIG. 1.—Outline map of the United States, suggesting the possible area adapted to the production of peanuts.

Sandy loam soils that will produce good crops of beans and potatoes are considered suitable for growing peanuts.

The territory indicated on the dark portion of the map shown in figure 1 is, for the most part, adapted to the production of peanuts. Outside of this area their cultivation is more or less uncertain, although in a few localities they may be grown successfully for stock feeding. The soil and climatic conditions of southeastern Virginia and northeastern North Carolina seem to be especially adapted to the growing of the Virginia Bunch and Virginia Runner varieties, which constitute the bulk of the large-podded, or "Jumbo," peanuts appearing on our markets. Throughout the Gulf coast region, Oklahoma, and Arkansas the Spanish variety has proved most satisfactory.

SELECTION AND PREPARATION OF THE SOIL.

In selecting land for peanuts, two things must be considered: (1) The character and adaptability of the land and (2) the character of the crops planted or the rotation practiced during previous years. The peanut crop is subject to injury from crab-grass and other weeds; therefore, it should follow some crop that has been kept clean. Cowpeas, velvet beans, sweet potatoes, and Irish potatoes are good preparatory crops. Winter oats also are frequently followed by a late-planted crop of peanuts. Cornstalks or cotton stalks interfere greatly with the cultivation and harvesting and should be either removed or plowed under to a depth of at least 8 or 9 inches.

Peanuts should not be planted on the same land oftener than once in three or four years. The rotation should include at least two soil-building crops, one of which is a winter cover crop. Cowpeas, velvet beans, or soy beans, planted either alone or with corn, are good soil builders. Winter cover crops include bur clover, crimson clover, giant red clover, alfalfa, vetch, rye, barley, purple-top turnips, and English cowhorn turnips.

In a rotation experiment being conducted at the Virginia Truck Experiment Station, near Norfolk, the crop rotation consists of corn with crimson clover as a winter cover crop during the first year, early Irish potatoes followed by cowpeas the second year, and Spanish peanuts the third year, followed by rye as a winter cover crop. Alongside of the three plats handled in rotation is a similar plat on which peanuts are grown continuously. This experiment has extended over a period of 10 years, and for the past 3 years the rotation plats have yielded approximately three times the quantity of peanuts produced on the continuous plat.

Plowing should be done at least six weeks before planting time. If considerable rough material is to be turned under, fall or winter plowing should be practiced except on soils that wash badly. Buck-shot or other heavy soils on which peanuts are grown for stock feeding are benefited if turned up to the action of frost during the winter months.

Thorough preparation of the land before planting is essential. The Virginia peanut grower, although his land is naturally mellow, plows every inch of space, then harrows and drags it at least three times or until the soil is in the best possible condition. The subsequent cost of cultivation is thereby greatly reduced. The land should be plowed broadcast, preferably with a 2-horse turning plow, rather than "bedded," as is often done for cotton or corn. With good seed and thorough preparation of the soil the Virginia farmer secures a good stand, without which a profitable crop can not be made.

FERTILIZERS.**USE OF STABLE MANURE.**

Stable manure should be applied to a crop grown in rotation with peanuts rather than to the peanut crop. Well-rotted manure, if thoroughly mixed with the soil, may be applied in small quantities at the time the land is being fitted. Fresh manure, however, should not be used at planting time, as it has the tendency to produce a large percentage of poorly filled pods or "pops."

APPLICATION OF COMMERCIAL FERTILIZERS.

Commercial fertilizers, having an analysis of 8 per cent phosphoric acid, 2 per cent nitrogen, and 2 or 3 per cent potash, such as are ordinarily used for corn and cotton, may be profitably applied at the rate of 300 to 500 pounds to the acre. An application of a mixture consisting of 200 pounds of 16 per cent acid phosphate and 100 pounds of cottonseed meal per acre is frequently made. Where sweet potatoes, Irish potatoes, or any heavily fertilized crop has been grown the previous year, an application of 200 pounds of commercial fertilizer of the above formula to the acre will usually be sufficient. The use of commercial fertilizers is not so important where soil-building crops are grown in the rotation.

Commercial fertilizers are usually applied just before planting the peanuts. However, if applied three or four days in advance they will become better mixed with the soil. Roots of the peanut do not spread far from the row, and the best results may be secured by sowing the fertilizer directly in the row, using a 1-horse fertilizer distributor. One or two shovels fitted to the back of the distributor will aid greatly in mixing the fertilizer with the soil.

IMPORTANCE OF LIME.

The Virginia peanut grower considers the use of lime essential in order to insure the proper development of the pods. Not all soils require the addition of lime, but wherever doubt exists, an application of 400 to 800 pounds to the acre should be made. As a general rule, the silt loams of the river valleys and delta regions contain plenty of lime. This is also true of many of the sandy loam soils on which peanuts are grown. Experimental data obtained at the department substation at Florence, S. C., indicate that no benefit is to be derived from the use of lime in growing peanuts on the soil of that region. It should be borne in mind that the lime requirements of adjoining farms may differ and that the only way to determine the matter is by applying lime to a portion of the crop and observing results.

Lime should not be applied at the same time as commercial fertilizer but either a week or 10 days in advance or later as a dressing alongside the rows of peanuts. Lime should not be plowed under but sown broadcast after plowing and harrowed into the surface. In Virginia where marl beds abound, 10 to 15 1-horse cartloads per acre are sometimes scattered upon the land during the winter months as a substitute for lime.

WOOD ASHES.

Hardwood ashes are a desirable fertilizer for peanuts, as they contain both potash and lime. Unleached wood ashes, particularly those from hickory, oak, and similar hardwoods, may be applied broadcast at the rate of 800 to 1,200 pounds to the acre. Ashes produced from the burning of pine and other soft woods and hardwood ashes that have been exposed to the weather are of little value as a fertilizer.

THE PEANUT AS A NITROGEN GATHERER.

Peanuts as ordinarily handled do not improve the soil, despite the fact that they have the power of collecting the free nitrogen of the atmosphere and storing it in nodules upon their roots (fig. 2). If, in harvesting, the greater part of the roots can be cut off and left in the ground, the drain on soil fertility is reduced to a minimum. The fact remains that, because of the system of harvesting followed, peanuts do not have the same effect in improving the soil as do the clovers, cowpeas, velvet beans, soy beans, and alfalfa, the root systems of which are not removed from the ground.

PEANUT SEED AND ITS CARE.

PRODUCTION AND SELECTION OF SEED.

High-grade seed is just as important with the peanut as with corn, wheat, or any other farm crop. Poor seed peanuts have been responsible for most of the failures to secure a good stand. In almost every community at least one and often several growers have a particularly good strain of seed peanuts. If such seed can not be obtained locally, arrangements should be made, preferably through the county agent or by an organized group of farmers, to secure, well in advance of planting time, an adequate supply of high-grade seed from some outside source.

The corn and wheat crops of the country have been increased many millions of bushels through seed improvement, and the same opportunity exists with peanuts. The proper method of producing seed is to grow a special seed patch, the seed for which has been selected from vigorous, high-producing plants the previous year. If this

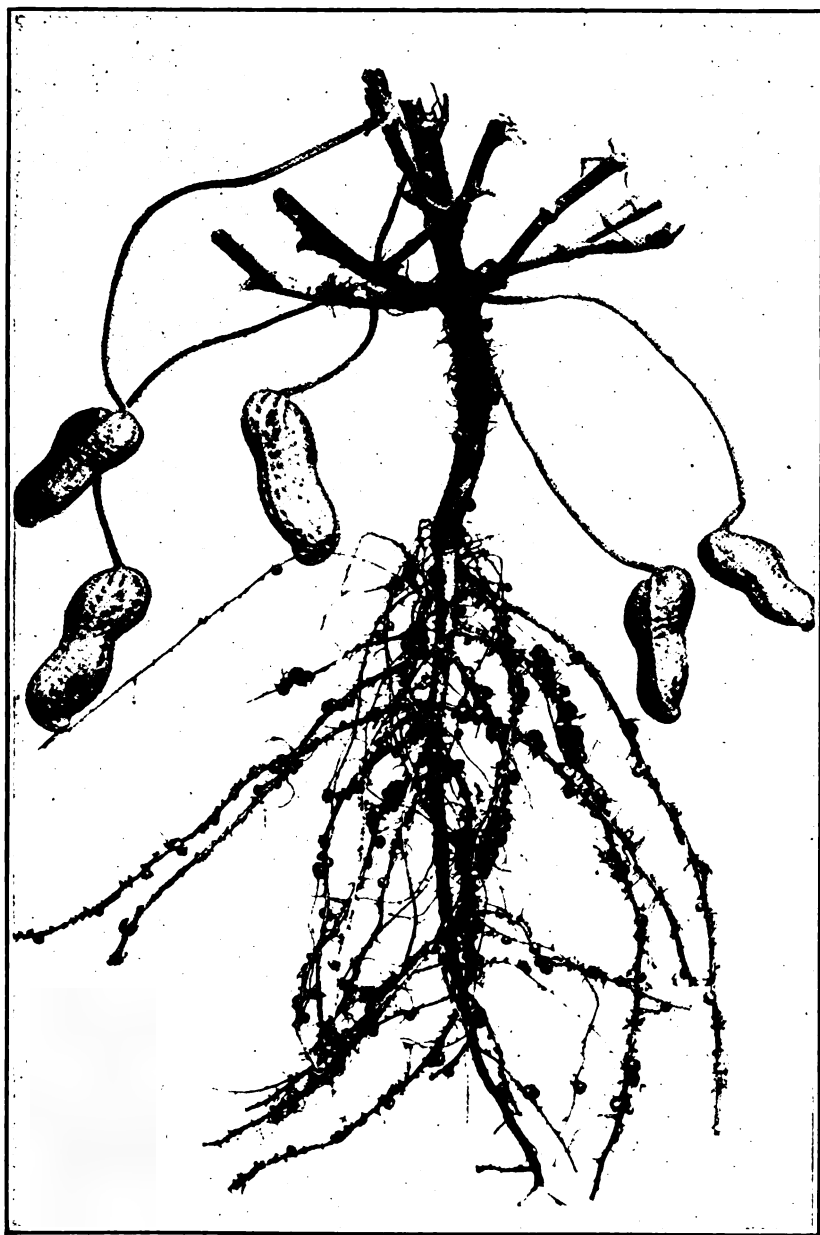


FIG. 2.—Roots of a peanut plant, showing nodules formed by the bacteria which collect nitrogen.

plan is not followed, a section of the field where the crop is especially good should be set aside and saved separately for seed.

Peanuts intended for seed, after becoming fully mature, should be dug carefully during bright weather, and placed in small stacks around poles, as described under "Stacking." After a curing period of at least eight weeks, the seed peanuts should be picked from the vines and stored in bags in a dry building. Preferably they should be hung from the joists or rafters by wires, so that rats or mice can not destroy them. Where not more than 20 bushels of seed are required, the picking should be done by hand; but when a large amount is needed a peanut picker that will not break the pods may be employed.

PREPARATION OF SEED FOR PLANTING.

During the winter, when there is spare time, the seed peanuts should be taken down and carefully cleaned by hand and any remaining trash removed. If a large quantity is to be cleaned, the peanuts may be again run through the picking machine, if available, under heavy fan blast, to take out all light or inferior pods as well as any remaining stems or particles of trash. This can best be handled on a community basis in charge of a central leader. It is also important that the greater part of the small stems or tails that attached the pods to the vines be removed. (Fig. 3.) After cleaning, the peanuts should again be bagged and hung up until needed for planting. A rat-proof seed room constructed of closely woven galvanized wire is desirable where large quantities of seed are to be stored.

Any breakage or injury to the thin red covering of the seed will affect germination. Seed of the large-podded varieties is practically all shelled by hand within two weeks of planting time. Varieties of the Spanish type are more difficult to shell by hand, and where large quantities of seed are required small hand shellers, carefully operated, may be used without serious injury. Breaking the pods in two serves the same purpose as shelling. A large percentage of the Spanish peanut seed is first soaked in the shell for 12 to 24 hours in cold water; then drained and spread on sheets for 1 or 2 hours or until dry enough to handle. Planting is done either by hand or with a peanut planter adapted to handling seed in the shell. Shelled seed should not under any circumstances be soaked before planting, as the swelling of the seed bursts the red covering and injures germination.

In sections where salamanders, moles, and other rodents destroy the peanut seed after planting, it should be spread upon the floor or on a wagon sheet, sprinkled with a solution containing equal parts of pine tar and kerosene, and stirred to distribute the mixture uni-

formly. The entire surface of the pods need not be coated, only a small amount being necessary to repel the rodents. The application

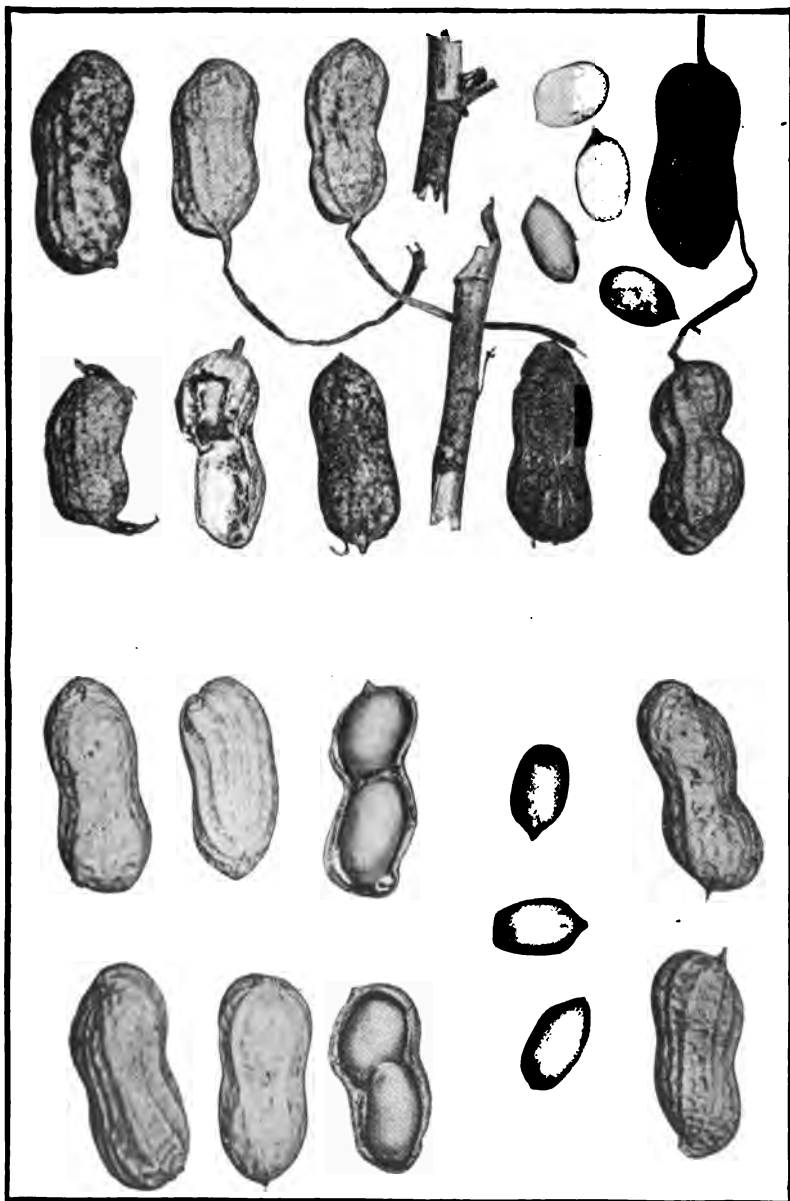


FIG. 3.—Seed peanuts. Top, including inferior nuts and trash as delivered by the picker. Bottom, re-cleaned and hand-selected peanuts.

of the tar solution in moderate quantities to shelled seed will not injure its germinating qualities if the work is done carefully.

SEED REQUIRED TO PLANT AN ACRE.

From 32 to 48 pounds of Spanish peanuts in the shell will plant an acre, the amount depending upon planting distances. To plant the same area with shelled seed will require from 23 to 34 pounds. With the large varieties, 24 to 30 pounds of shelled seed are required to plant an acre.

TIME AND METHODS OF PLANTING.

TIME OF PLANTING.

Throughout the greater part of the commercial peanut area, the planting of the main crop is done between April 10 and May 10, but in no case should the seed be planted until the soil is reasonably warm. The large varieties require a longer period for their development than do those of the Spanish type. Best results are secured from early planting, but in the Gulf coast region Spanish peanuts may be planted as late as July 1 and a fairly good yield secured. When large acreages are grown, plantings should extend over a period of at least three or four weeks, so that the entire crop will not be ready for harvesting at one time.

PREPARATION OF LAND FOR PLANTING.

If the land has been well fitted and leveled, the rows at planting time may be laid off with a 1-horse marker. The fertilizer is then distributed, as described under "Application of commercial fertilizers," and the peanut planter run along the same marks. A planting gang, consisting of a team attached to the harrow, a 1-horse marker, two fertilizer drills, and two peanut planters, will plant 10 or 12 acres a day. On a small scale two men with a double team can work to advantage. First, a section of the field is dragged or harrowed; the team is then split, one horse being used to mark the rows and sow the fertilizer, while the other is employed to draw the peanut planter. From 4 to 5 acres a day may be planted in this manner.

DISTANCES TO PLANT.

Planting distances depend upon the type of tools used in cultivation, the character of the soil, and the variety of peanuts grown. The usual distance between rows is 36 inches, but varies from 32 to 42 inches, according to localities and conditions. The distance at which the seed is spaced in the row also varies according to variety and local conditions.

Experiments conducted recently by the Department of Agriculture at its substation at Florence, S. C., show conclusively that on the light sandy loam soils of that region the highest yields are

secured where the seeds of the Spanish and Virginia Bunch varieties are dropped very closely in the row, the best yield being obtained at a distance of 3 inches, with the rows 30 inches apart. Whether this would hold good on the rich river-bottom lands in certain parts of the South is a question, but there can be no doubt that a better stand and a higher yield will under most conditions be secured by

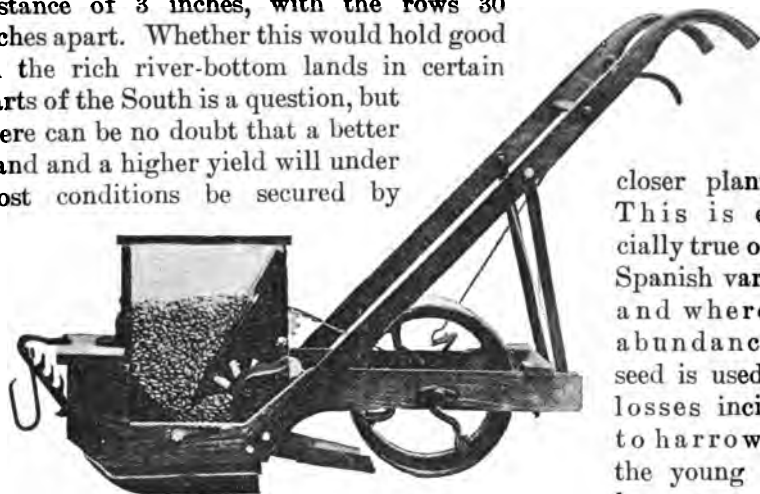


FIG. 4.—A 1-horse peanut planter.

closer planting. This is especially true of the Spanish variety, and where an abundance of seed is used the losses incident to harrowing the young crop become a negligible factor.

A table of planting distances for the various varieties of peanuts follows:

Table of planting distances for peanuts.

Variety.	Distance (inches).		Variety.	Distance (inches).	
	Between rows.	In rows.		Between rows.	In rows.
Spanish.....	32 to 38	7 to 10	Virginia Bunch.....	32 to 38	8 to 12
Valencia.....	32 to 38	7 to 10	Virginia Runner.....	36 to 42	12 to 18
Tennessee Red.....	32 to 42	8 to 12	North Carolina.....	34 to 38	12 to 15
Georgia Red.....	32 to 42	8 to 12	African.....	36 to 42	12 to 18

DEPTH TO COVER THE SEED.

Peanut seed should be covered to a depth of $1\frac{1}{2}$ to 2 inches on light sandy soils and 1 to $1\frac{1}{2}$ inches on the heavier soils. If the soil contains plenty of moisture the depth should be less than if moderately dry. Slight firming of the soil over the seed is desirable, and the modern planting machines are fitted with a concave wheel that follows the covering blades and slightly rolls or firms the soil. Much depends upon the care taken by the operator of the planting machine, to see that it is dropping and covering properly. Some of the machines now on the market are fitted with agitators, which keep the peanuts from packing together in the hopper. Plenty of seed should be kept in the machine, and any remaining stems or trash removed frequently in order to prevent clogging. A peanut planter is shown in figure 4.

PLANTING BY HAND.

When planting seed by hand, a small furrow is opened with a single-shovel plow, the seed dropped, and covered with a 1-horse cultivator or with a hand hoe. A notched board attached to the back of the cultivator will form a slight ridge of soil directly over the row.

CULTIVATION.

Cultivation of the peanut crop should begin as soon as the rows can be followed, and continue until the vines occupy the greater portion of the ground. Frequent shallow cultivation, similar to that given beans and peas, is the keynote of success in the production of a peanut crop. As soon as the soil is reasonably dry after heavy rains the surface should be stirred, and during dry weather a soil or dust mulch will help to conserve moisture. In some sections of Virginia and North Carolina, on the sandy loam soils that are free from trash, the peanuts are harrowed carefully about a week after they are up, using a light spike-tooth harrow with the teeth set sloping back. At least one hand hoeing will be necessary, and the best time to do it is usually about the time the plants begin to spread, or following the third cultivation. About five cultivations are required; however, their number will depend entirely upon weather conditions.



FIG. 5.—A 1-horse cultivator.

IMPLEMENTS FOR CULTIVATION.

In most sections of the South sweeps and 5-tooth cultivators are already on the farms. Of the two the 5-tooth cultivator is preferable, especially if provided with two or three sizes of shovels. The first one or two cultivations should be with the $1\frac{1}{2}$ inch or narrow shovels, and subsequent workings with the $2\frac{1}{2}$ or 3 inch shovels or points. (Fig. 5.) By working with the soil toward the rows during cultivation a broad, flat bed of earth will be formed, leaving a water furrow between the rows.

On light sandy soils, such as are found in many sections of the peanut territory, the greater part of the work of cultivation can be done by means of a 1-horse weeder of the special type shown in figure 6. This tool is light, and can be dragged diagonally across the

rows, first in one direction and then in the other, without serious injury to the plants. At the substation at Florence, S. C., it has been found that practically no hand hoeing is necessary where the crop is worked about twice a week with this type of tool until the "pegs" begin to form. After the pegs begin to take hold of the soil a riding cultivator may be used between the rows. A small tooth should be placed next the row, and so adjusted that it will not go more than 2 inches into the soil. Next to this there should be a large tooth, and a sweep in the center of the row. The vines must not under any circumstances be disturbed after they begin to "peg down," and only the middles should be cultivated after the pods begin to form. (Fig. 7.)

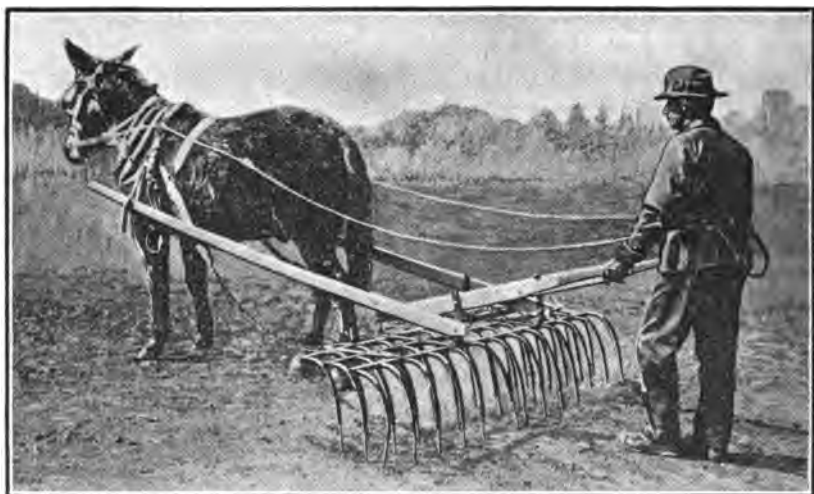


FIG. 6.—Type of weeder often used for the first cultivation of peanuts.

After the "pegs" or pods begin to form they should not be disturbed, but a narrow cultivator or sweep should be used to keep the middles clean and work a little loose soil under the sides of the plants, thus providing a bed of fine earth in which later pods may form.

SPECIAL CULTURAL PRACTICES.

Shoveling dirt upon the center of the peanut plants injures the quality of the hay, and it is doubtful whether a greater number of pods is formed. Running a light roller over the plants after the final cultivation to flatten the stems upon the ground and enable the little "pegs" to reach the soil may be desirable in the case of the 'spreading varieties, but is a questionable practice with the Spanish or any of the erect-growing types.

The primary object should be to so cultivate the crop that the largest possible number of perfect pods will set and mature at the same time, yielding a uniform product.

HARVESTING, STACKING, AND CURING.

TIME OF HARVESTING.

Peanuts should be harvested before the vines are killed by frost. When to harvest the crop may be determined in two ways: (1) By a slight yellowing of the foliage, and (2) by an examination of the pods. If the peas are full grown and the inside of the shells has begun to color and show darkened veins it can be assured that they are ready for harvesting. The tendency of many farmers has been to dig too early and before most of the peanuts have fully developed. On the other hand, if harvesting is deferred too long the peanuts shed their leaves, and in the case of the Spanish variety many kernels will be lost by sprouting, especially if a rainy season should occur.



FIG. 7.—Peanut flower and the pegs that form pods.

METHODS OF DIGGING.

Peanuts should be loosened from the soil by means of a sharp implement that will cut off the greater portion of the root system on which the nitrogen nodules are borne. A number of diggers of the plow type that do this in a fair manner are on the market; there are also special peanut points to be attached to an ordinary turning plow. (Fig. 8.) A very simple and effective type of peanut digger consists of a sharpened, curved steel bar, which is attached to a Georgia plowstock, as shown in figure 9.

The practice of digging peanuts with the ordinary 1-horse plow or a Georgia stock with a sweep attached has been to some extent

responsible for the depletion of soil fertility in the peanut fields of Virginia and North Carolina.

Regular machine potato diggers with elevators (fig. 10) have been found very satisfactory where the soil is reasonably dry and

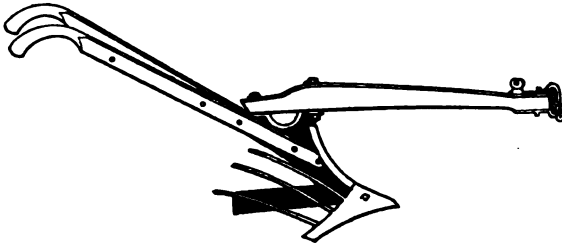


FIG. 8.—Plow type of peanut digger.

the crop is free from grass. These machines not only lift the peanut from the ground, but also shake off the soil, as shown in figure 11. By regulating the depth of the point, the roots can be cut

off just deep enough to avoid loss of the pods, leaving most of the nitrogen-bearing nodules in the soil.

Digging should not begin in the morning until the vines are dry, and no more should be dug than can be placed in stacks during the day.

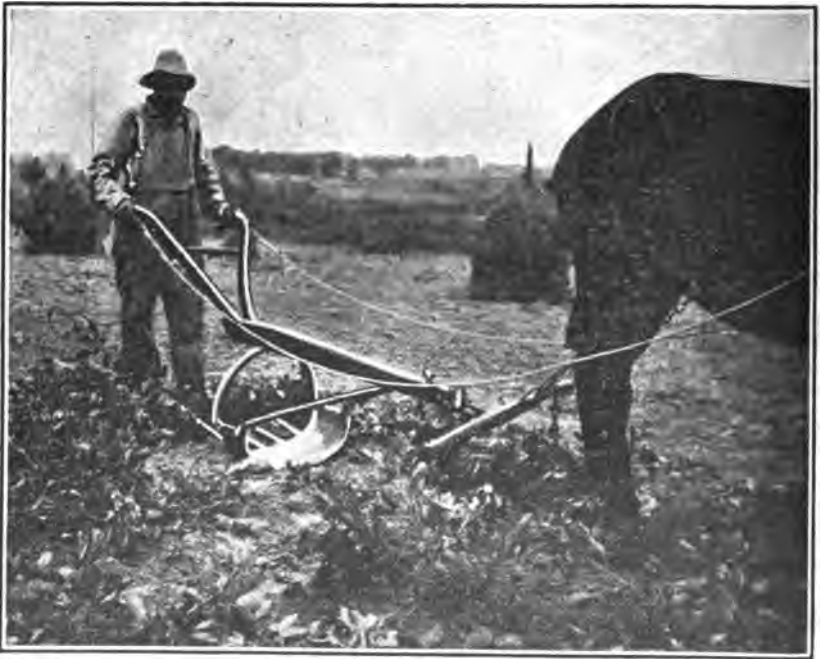


FIG. 9.—A simple and effective peanut digger made by a local blacksmith.

CURING THE VINES AFTER DIGGING.

After the peanut vines are loosened and the soil shaken from them they are allowed to lie either spread upon the ground or in small

bunches until the leaves are slightly wilted, but not until they become curled or brittle. If the weather is suitable for curing the crop, stacking may begin within an hour or two after digging.

STACKING.

There is but one right way of curing peanuts and that is by putting them in small stacks around poles, to which two crosspieces have been nailed a few inches above the ground. Curing in windrows may succeed about one year out of five in sections having little rainfall at harvesting time, but the farmer who uses this method is always taking a great risk of losing his crop.

Small poles or split stakes 3 to 4 inches in diameter at the base, cut 7 feet in length and sharpened at both ends, are the best type of

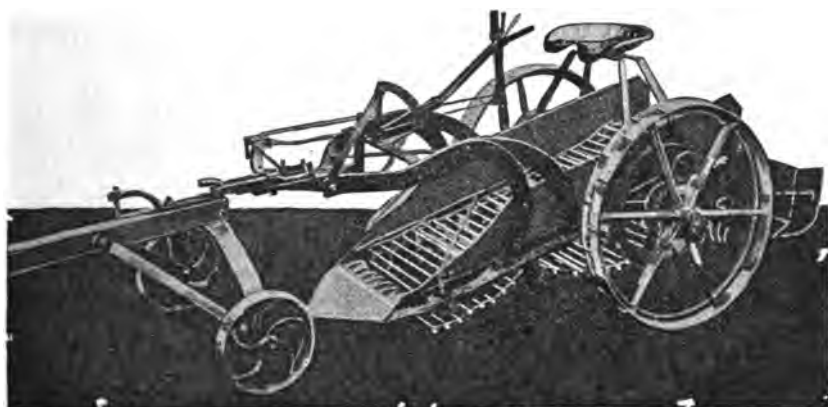


FIG. 10.—Potato digger used for harvesting peanuts.

stake around which to stack peanuts. The crosspieces should be 14 to 18 inches long and may consist of edging strips from the saw-mill or short pieces of split timber similar to stove wood. From 15 to 30 stacking poles will be required for an acre, and both poles and crosspieces should be ready for use well in advance of harvesting time. Two crosspieces only are required for each pole, and these are nailed at right angles one directly above the other, as shown in figure 12.

Then 12 to 14 rows of peanuts are placed in a stack row. After a sufficient number of rows are dug the stakes are distributed and set by making holes with a post-hole digger, crowbar, or an old wagon axle, inserting the stake, and tamping the soil firmly around them so that they will not blow over with the weight of the stack upon them. The crosspieces are then nailed on at right angles to each other 8 to 12 inches from the ground.

For assembling the peanut vines around the stacking poles a fork having six or eight tines is the best implement. As the vines are brought together they are laid in a circle on the ground, with the roots toward the pole at a convenient distance from the pole, so that the person doing the stacking can work comfortably. In starting to build the stack a few vines are hung over each of the crosspieces, thus forming a foundation. The stack is built by piling the vines around the pole by hand, pressing them down, and keeping all the peanuts on the inside next to the pole. (Fig. 13.) Occasionally a bunch should be divided and hung around the pole in order to bind the stack together and to keep the center about 1 foot higher than the outside, that the stack may shed water. Where the vines are ex-



FIG. 11.—Potato digger used for digging peanuts.

tremely long the center of the stack should be kept high from the start. In order to provide free circulation of air and prevent the possibility of the nuts heating and souring in the stacks, under no circumstances should the stacks be more than 36 to 42 inches in diameter.

As the stack nears completion it should be gradually drawn to a point and a few vines crowded down over the sharpened top of the stake to complete the stack. A little dry grass or weeds may be placed on top of the stack, but too much will have a tendency to prevent circulation of the air through the stack and interfere with the proper curing of the peanuts. A typical completed stack is shown in figure 14.

Peanuts are, as a rule, stacked in the field where the crop is grown, but sometimes the vines are hauled to a central point where the

stacks are built close together and inclosed with a fence in order that the hogs may be turned into the field to gather the nuts detached in harvesting.

LENGTH OF CURING PERIOD.

Peanuts intended for the market should remain in the curing stacks at least six weeks before being picked from the vines. Peanuts cure rather slowly in the stacks, and if picked from the vines too soon the peas have a tendency to shrivel and there is more or less danger of molding or fermenting after picking. Where the peanuts, vines and all, are to be used for stock feed, they should be cured in stacks for at least two to four weeks before being stored in barns.



FIG. 12.—Poles around which stacks of peanuts are to be built.

PICKING AND CLEANING.

Picking the commercial peanut crop of the United States is done mainly during the months of October, November, and December. Peanuts can be picked satisfactorily only when the vines are dry and brittle, as damp weather causes them to be tough and the pods difficult to detach. If for any reason it is necessary to pick the peanuts when they are damp or before they are fully cured, they should not be stored in large quantities but spread thinly on a floor and stirred from time to time until dry. If bagged or stored in bulk before they are fully dry, they will go through a sweating or souring process that renders them unfit for the market or for seed.

METHODS OF PICKING.

Hand picking, as practiced in Virginia and North Carolina in the early days of the peanut industry (fig. 15), is no longer practicable with the commercial crop. A satisfactory peanut-picking machine must remove all of the marketable nuts from the vines with a minimum amount of breakage of the pods. Two types of picking machine are now on the market: One, working on the principle of a cylinder grain thrasher, and the other being provided with a wire mesh over which the peanuts are drawn in such a manner that they fall through and are pulled from the vines. The capacity of peanut-



FIG. 13.—Partly completed stack of peanuts, showing the method of placing the vines in stacking. Completed stacks are shown in the background.

picking machines depends upon the make of machine and the condition of the peanuts, about 250 bushels per day being an average. In addition to removing the pods from the vines, the machines have special facilities for cleaning them and taking off the small stems. (Fig. 16.)

In order that no time be lost by hauling the stacks long distances, the picker is set at a convenient point near the center of the field and in large fields may be moved two or three times to shorten the haul. The entire stack, pole and all, should be brought to the picker, none of the peanuts being wasted by this method, as would be the case if the vines were removed from the poles in the field. The poles can be loosened from the ground by means of a handspike thrust

underneath the crosspieces. Two men can then easily load the stacks upon low-wheeled wagons, and during the unloading the poles are drawn out and thrown to one side.

In sections where peanuts are extensively grown, a special 2-wheeled cart, as shown in figure 17, is frequently employed for hauling the stacks to the picker. The cart is backed against a peanut stack, the short chain, attached to the end of the lever, hooked around the top of the stacking pole, and the stack raised free from the ground by drawing down the long end of lever and securing it under a hook attached to the shaft. The outfit is then driven to the



FIG. 14.—Typical stack of peanuts at the time of completion and before it has settled.

picker, the lever released, and the chain unhooked from the stacking pole. By driving the horse in a trot, an outfit of this kind will move almost as many stacks to the picker as a 2-horse team attached to a wagon with two men to load and unload it. The cart, however, gives best results where the haul is short.

Slow, uniform operation of the picking machine will secure best results both as to quality and quantity of peanuts, and if the vines are either damp or extremely dry the machine will need to be adjusted to suit their condition. Four or five men are required to operate the machine; one to place the peanut vines in small forkfuls

upon the feeding table, one to feed them uniformly through the machine by hand, one to handle the peanuts as they are delivered from the machine, one to throw back the hay, and one to attend to the oiling and care of the machine.

BAGGING.

Most of the peanut-picking machines have a bagging attachment, and the peanuts go directly into standard peanut bags. These are 32 by 36 inches in size and hold approximately 120 pounds of Spanish peanuts. As the bags are filled, they are taken from the machine and the opening closed by sewing with a bagging needle and soft



FIG. 15.—Old-fashioned method of picking peanuts from the vines by hand.

twine. The bags are then hauled direct to a barn or storage shed. If on account of shortage of teams the peanuts can not be hauled to the storage place the same day they are picked, the bags should be piled on a foundation of poles and securely covered with canvas or peanut vines, to protect them, for a day or two, until they can be hauled.

Peanuts as they come from the picker frequently contain more or less moisture and should be stored so as to permit a free circulation of air. The building in which peanuts are stored should have a good roof and the bags should be fully protected from rain. The bags should not be piled directly upon the ground or on a tight floor, but poles or 2 by 4 scantling should be placed under them to provide ventilation. Great losses occur in the farm storage of peanuts from

the ravages of rats and mice, which not only destroy the nuts but by cutting holes in the bags cause serious losses during subsequent handling. Any storage can be made rat and mouse proof by lining it with woven wire the meshes of which are less than one-half inch.

CLEANING AND GRADING PEANUTS FOR THE MARKET.

Sometimes the peanuts are ready to market as they come from the picker; but more often there is more or less rubbish, including broken stems, light pods, roots, sand, and small stones, which must be removed before the peanuts are in condition to market. The grading is accomplished by recleaning, during which the trash and light pods are blown out. Special fanning mills are sometimes employed for this purpose, or the peanuts may be again passed through the picking machine, utilizing the cleaning device. In recleaning, the



FIG. 16.—Peanut picker and crew.

peanuts may be fed through the picker in a steady stream as fast as they can be handled by the cleaning attachment, a heavy air blast being maintained. After being recleaned, they are resacked in new sacks. Each sack is weighed, and the weight and grade marked upon it. The peanuts are then ready for marketing.

GRADES OF PEANUTS.

Standard grades of peanuts have been adopted in several of the Southern States, based upon the quantity or percentage of first-class kernels that may be shelled from a given sample. In June, 1919, the Southern Peanut Crushers' Association adopted the following rules for the grading of peanuts:

SECTION 1.—There shall be four general classes known as "White Spanish," "Bunch," "Runners," and "Mixed." There shall be three grades of each class, known as No. 1, No. 2, and No. 3.

SEC. 2. These grades shall be based upon the percentage of total sound and matured kernels as follows:

- No. 1. Not less than 70 per cent sound and mature kernels and not more than 3 per cent damaged.
- No. 2. Between 65 and 70 per cent sound and mature kernels and not more than 3 per cent damaged.
- No. 3. Between 60 and 65 per cent total sound and mature kernels and not more than 3 per cent damaged.

SEC. 3.—Off grades, showing any of the following, to be sold according to sample:

- A. Moisture present in excess of 7 per cent.
- B. Hulls black or moldy in excess of 5 per cent.
- C. Less than 60 per cent sound kernels and over 3 per cent damaged.
- D. Any mixture of red peanuts.
- E. Mixture of other varieties in excess of 2 per cent.
- F. Shelled nuts in excess of 2 per cent.

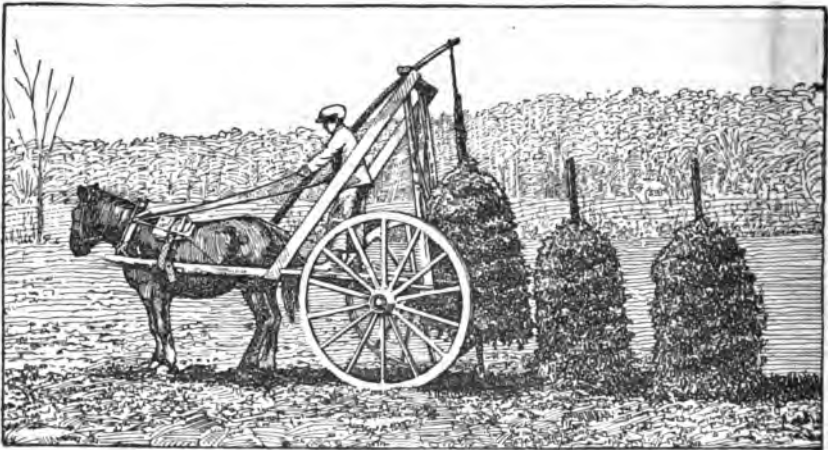


FIG. 17.—Device used for lifting peanut stacks and moving them to the picker in the field.

SEC. 4.—Mixed peanuts shall include:

- A. Any mixture of other varieties.
- B. Any varieties containing more than 2 per cent of shelled nuts.

SEC. 5.—"Sound kernels" shall mean those that are bright, mature, and marketable.

"Damaged kernels" shall mean those that are not prime in flavor, or show mold, sourness, rancidity, or are wholly or partly decomposed.

"Shelled nuts" shall mean all those that are shelled, including whole and broken kernels.

SEC. 6.—Percentages by weight shall be based on the samples of farmers' stock, hand shelled.

SEC. 7.—Deduction at the rate of delivered price shall be made for all foreign matter in excess of 1 per cent and for moisture in excess of 7 per cent.

SEC. 8.—Six samples of 5 pounds each shall constitute a fair sample to be taken from various parts of each car and two samples of 2 pounds each from a wagonload. These samples shall be thoroughly mixed, then quartered, and 100 grams shelled by hand as a basis for determining grade.

MARKETING BY WEIGHT.

Peanuts should always be sold by actual weight rather than by the bushel. Considerable confusion has arisen from the use of the "bushel" as a measure for handling and selling peanuts. The large-podded varieties will, as a rule, weigh about 22 pounds and the Spanish from 28 to 30 pounds to the measured bushel, but these weights are not constant and vary with locality, grade, and condition of the stock. If sales are conducted on the basis of tons or hundredweight and according to standard grades, both buyer and seller will have in mind a definite standard.

MARKETS FOR PEANUTS.

Peanut-cleaning factories and oil mills are essential in the preparation of the peanut and its products for the retail market. As the many and varied uses developed for peanuts require intricate and expensive machinery, this work can not be done to advantage on the farm. Therefore, when the farmer has recleaned and graded his crop and delivered it to the shipping point or to the factory in the best possible condition, his connection with the work ends.

PEANUTS AND PEANUT BY-PRODUCTS AS STOCK FEED.

Peanuts are exceptional among southern farm crops in that every part of the plant and all by-products resulting from the factory processes through which peanuts pass can be utilized to splendid advantage mainly for stock feeding. Peanut hay and the light or inferior pods constitute the by-products on the farm; hulls, press cake, and meal result from the manufacture of peanut oil; hulls, shrunken and inferior kernels, germs, and fine particles of meats are by-products of the cleaning factories; and considerable quantities of germs, red skins, and inferior particles of meats result from the manufacture of peanut butter and peanut confections.

VALUE OF PEANUT HAY.

Peanut hay, or the vines from which the pods have been removed, was at one time allowed to go to waste, but now constitutes a considerable portion of the farmer's profit and has a decided market value, as hundreds of carloads are sold. Where the vines are properly cured in stacks, the hay will come from the picker bright and clean, with a feeding value equal to, if not greater than, first-class clover or alfalfa hay. Sufficient attention has not been given by the manufacturers of peanut-picking machinery to providing proper attachments for handling and cleaning the hay. If these machines were provided with better facilities for separating the dirt from the hay,

less difficulty would be experienced in feeding it. By proper manipulation of the picking machines now in use much of the sand and dust can be separated from the hay and its value increased. As a rule a baling machine is employed either in conjunction with the picker or following behind and packing the peanut hay into bales. Care must be taken in baling to mix the leaves and stems so that the product will be uniform. Peanut hay should be baled when dry and the bales stored where they will not be exposed to the weather.

PRECAUTIONS NECESSARY IN FEEDING PEANUT HAY.

Moldy peanut hay is unfit for feeding purposes, but hay that has been properly cared for may be fed to all kinds of live stock. In feeding to mules and horses it should be fed in racks or wire-bottomed mangers, in order that any sand or dust may sift through. Cases are on record where both horses and mules have been injured by feeding either moldy or extremely dusty peanut hay, the symptoms frequently being similar to those of ordinary colic.

USE OF LIGHT AND INFERIOR PODS.

All light or inferior peanuts removed in recleaning and grading may be used for feeding hogs on the farm, or they may be ground, shells and all, mixed with other ingredients, and used as dairy, poultry, or hog feed.

BY-PRODUCTS OF PEANUT-OIL MANUFACTURE.

With the establishment of the peanut-oil industry in the Southern States, a line of practically new by-products has appeared upon the market, peanut cake and peanut meal being the most important. In the production of the highest grade virgin peanut oil, the nuts are shelled and hand picked just the same as for the confectioners' trade, and the press cake resulting is of a very high grade, containing 36 to 42 per cent protein. Where the nuts are crushed, shells and all, a lower grade cake and meal results, but even this makes a highly concentrated feed. It is estimated that with cottonseed meal selling at \$55 per ton, high-grade peanut meal is worth not less than \$65 per ton. When fed to dairy animals, peanut meal does not give the milk any peculiar flavor, as does cottonseed meal, and it can be fed continuously to hogs without any of the injurious effects produced by cottonseed meal. Peanut meal made from shelled nuts is more desirable for hog feeding than that which includes the shells.

Both peanut meal and the by-products resulting from cleaning peanuts for oil making find a ready use in the manufacture of mixed dairy feeds. The shells that were formerly burned or used as stable bedding are now ground and used as a filler in prepared feeds.

In feeding pure peanut meal, reasonable precaution should be taken as regards the amount fed, on account of its high protein content. The safest plan is to mix it with other feeds, forming a balanced ration.

PEANUTS AS A FEED FOR HOGS.

Until recent years the greatest use for peanuts in the Gulf coast region was for feeding to live stock on the farms. The production of peanuts for the market in that section has been a transition from the stock-feeding phase. While there may be a few disadvantages connected with the feeding of peanuts to hogs, the fact remains that they are one of the most profitable hog feeds on southern farms.

There is a wide diversity of opinion relative to the effect of peanuts in producing soft pork. In this connection it should be borne in mind that peanuts are not the only feed that produces soft pork. Numerous experiments have been conducted to determine the extent to which the softening effect of peanuts can be overcome by finishing hogs on corn or some other concentrated feed. Thus far no definite conclusions have been reached, and further investigations are necessary before there can be an agreement among investigators. However, two or three definite facts are known: (1) There is no means by which the hogs that will kill soft may be detected until the carcasses have been chilled. (2) As a rule, peanut-fed pork will shrink more in the curing processes than that fed on corn and certain other concentrated feeds. (3) The processes used in the curing of corn-fed pork are not adapted to curing the pork from hogs that have been fed on peanuts.

As long as the difference in the price paid by the packers for peanut-fed hogs is no greater than at present, namely, from 1 to 2 cents per pound, the southern farmers should fatten hogs on peanuts wherever a considerably greater quantity of pork can be produced from an acre of peanuts than of corn. It has been found in certain sections of the South that more pork could be produced per acre with corn than with peanuts, and in those cases the farmers would certainly not be justified in depending upon peanuts. The flavor and table quality of pork produced in part upon peanuts are beyond question. Much of the difficulty has arisen on account of the methods used in curing the peanut-fed pork. The Virginia housewife and the packer who make a specialty of peanut-fed hams know and apply the difference in method.

VARIETIES FOR FEEDING PURPOSES.

Where peanuts are grown exclusively for feeding purposes, successive plantings should be made; also more than one variety used.

The Spanish is undoubtedly the best all-round variety for feeding purposes, but has the disadvantage that the seeds are liable to sprout in the ground if wet weather occurs after they are mature. The Tennessee Red, the Georgia Red (sometimes called Red Spanish), and the Valencia have the characteristic of remaining in the ground without sprouting throughout the autumn, and sometimes until nearly spring, and for that reason are especially adapted for hog feeding. The variety known as African matures late and produces a large number of pods.

Spanish and similar varieties having an upright habit of growth are frequently mowed for hay, after which the hogs are turned in to harvest the peanuts. Another method is to first mow the tops



FIG. 18.—Peanuts growing between rows of corn.

for hay, dig and stack the greater part of the peanuts, and then turn in the hogs. Owing to their low spreading habit of growth the Virginia Runner, North Carolina, and African are not adapted for handling in this manner. In many parts of the South peanuts are planted between the rows of corn, as shown in figure 18.

VARIETIES OF PEANUTS.

Nine or ten distinct varieties of peanuts are grown in this country, but there are a number of hybrids, off types, and mixtures of these. The varieties known as Virginia Bunch, Virginia Runner, and North

Carolina furnish the greater part of the large-podded peanuts on our markets. According to good authority the Virginia Runner and Virginia Bunch were originally one variety, a few plants of bunch habit of growth being selected from among the runners and eventually developed into a distinct variety. The characteristics of these varieties are now clearly defined, and a number of special strains of each have been developed.

The Spanish, including the Small Spanish, medium white Spanish or true Spanish, and the Large or Improved Spanish, furnish the bulk of the shelled goods and those used for oil production. Varieties having red or dark-colored kernels are not desired on the markets, and any mixture of these with the standard white varieties lowers the grade of the latter.

Virginia Runner has a spreading habit of growth and forms pods both at the base of the plant and along the stems. It is rather difficult to dig without losing a few of the peanuts and to stack so that the nuts will not be exposed to the weather. This variety is grown extensively in southeastern Virginia and northeastern North Carolina.

North Carolina resembles the Virginia Runner except that it is smaller in every respect. It also has certain characteristics indicating that it may be closely related to the African. Peanuts of the North Carolina variety are used largely for shelling and small-sized vending stock.

Virginia Bunch has an upright or bunch habit of growth and the pods are formed in a cluster around the base of the plant. (Fig. 19.) It is easy to cultivate and is not difficult to harvest.

African is a low-growing, runner pea, requiring a long season for its maturity. It produces a heavy yield of peas, which are fairly high in oil content, but this variety has not found general favor on the market.

Spanish is the most important commercial variety in the South, especially outside of the Virginia-North Carolina district. The medium or true white Spanish, as shown in figure 20, is unquestionably best adapted for all purposes in the Gulf coast region and is the one most in demand by factories producing shelled goods for the market. This variety is of an upright habit of growth, has rather heavy foliage, and the pods cluster close about the base of the plants. It is easy to cultivate and to harvest.

Small Spanish. A variety or strain of Spanish known as Small Spanish is found in many sections in the Gulf coast region. The pods and peas are about two-thirds the size of those of the regular Spanish. It is not a high yielder, and the peas are a little too small to meet the market requirements.

Improved Spanish. A number of hybrids or selections from the true Spanish are known under the names of Improved Spanish, Jumbo Spanish, Large Spanish, and various other local names, their chief difference being that the pods and peas are larger than those of the true Spanish. Some of these are worthy of careful trial and cultivation, but their use is thus far confined to limited areas.

Valencia. The variety known as Valencia has a vigorous upright growth, with the pods clustered about the base of the plants, similar to Spanish. The peas are reddish in color and not considered desirable for shelling purposes.



FIG. 19.—Virginia Bunch peanuts.

Tennessee Red belongs to the Valencia type and is possibly a cross or a selection of that variety. Its pods are extremely long and slender, with three to seven red peas in each. It is not extensively used for shelling, but is sold for roasting in the shell.

Georgia Red, sometimes called Red Spanish, is another variety closely related to Valencia. Its pods are short, usually containing two or three light-red peas. This variety is grown extensively in Georgia, Florida, and Alabama, especially for hog feeding.

VALUE OF PEANUTS AS A MONEY CROP.

Too much can scarcely be said in favor of the peanut as a money crop for southern farms wherever the character of the soil, the climate, and the local conditions are adapted to its production. The demand for peanuts is increasing as new uses and a wider market are found. In order that the grower may know where he stands as regards profits derived from his peanut crop, it is desirable that he keep a reasonably accurate account of all items of expense entering into its production.

COST OF GROWING AN ACRE OF PEANUTS.

It is assumed that if the cost of growing a single acre is known, the cost for the crop on any given farm may be determined with reasonable accuracy. Local conditions determine to a certain extent the cost of growing peanuts, and actual cost figures can not be given in a



FIG. 20.—Spanish peanuts.

publication for use throughout the peanut territory of the United States. The following items are those usually entering into the cost of production:

1. Rental of land or interest on the value of the land.
2. Supervision and overhead costs, including deterioration and interest on investment in tools, equipment, and storage houses.

3. Fertilizers, lime, or marl.
4. Seeds.
5. Bags and stacking poles.
6. Labor involved in the following operations:

(The cost of hiring a 1-horse team, or a 2-horse team and a driver, may be used as a basis.)

- a. Plowing and fitting the land.
 - b. Marking land, sowing fertilizers, and planting seed.
 - c. Cultivation.
 - d. Hand hoeing.
 - e. Digging and stacking.
 - f. Picking.
 - g. Recleaning and grading.
 - h. Hauling to market.
7. Miscellaneous expenses, including any preventable losses that occur from the ravages of rats and mice and any discounts or dockages due to peanuts not conforming to represented grade. These do not form a part of the actual growing costs and should be figured rather as losses.

YIELD OF PEANUTS.

Latest information places the average yield of peanuts in the United States at approximately 36 bushels per acre—800 to 1,100 pounds, according to variety—or an increase of 2 to 4 bushels per acre during the past 10 years. The yield per acre is influenced largely by locality and by the experience of the grower, but 40 to 50 bushels—900 to 1,500 pounds, according to variety—is considered a fair yield per acre. Many cases are on record, however, where a yield of 1,800 to 2,000 pounds to the acre has been harvested.

MARKET VALUE.

Definite figures as to the market value of an acre of peanuts change from year to year. If the yield and grade are known, it will be an easy matter to apply current prices and, allowing a reasonable value for the hay and waste products, compute the value of the product of an acre. By deducting the cost of growing, net profits may be obtained.

COOPERATION AMONG PEANUT GROWERS.

Peanut growers' associations have been formed in a number of the more important producing localities, and this class of organization is very desirable. Through the combined effort of associations much can be done to promote improvement in the methods and results of individual growers. The big problems to-day are the securing of high-grade seed for planting, better methods of harvesting and curing the crop, and conformity to standard grades in marketing. Until recent years the peanut industry has been characterized by a lack of standards and ideals, but this condition is rapidly giving way to a system employing the best business methods of the present.

TEN POINTERS FOR PEANUT GROWERS.

(1) Plant peanuts in rotation with corn, cotton, cowpeas, and other farm crops.

(2) Be sure your land is adapted to growing peanuts. Do not plant sour or poorly drained land to peanuts.

(3) Prepare your peanut land as though you were going to use it for a garden; then give it an extra fitting for good measure.

(4) Good seed is essential to a full stand and a profitable crop. What has been done with corn by way of seed improvement can also be done with peanuts. Have a seed patch and grow seed from high-yielding plants.

(5) Shell seed by hand, or in case of Spanish peanuts, soak the pods over night and plant whole. If troubled by moles or salamanders, treat the seed with a little pine tar.

(6) Cultivate early and often. Keep the grass and weeds from getting a firm hold.

(7) Have stacking poles ready before the crop is ready to harvest.

(8) Harvest during good weather before the vines are frosted. Cure in small stacks around poles having two crosspieces nailed to them 8 to 12 inches above the ground. There is only one right way.

(9) Allow peanuts to cure thoroughly in stacks; then pick them from vines with a machine that will not break the pods.

(10) Grade according to standard grades, pack in clean bags, and store in a dry well-ventilated storage room or building until marketed.

Grow the best, put them up the best, and get the highest prices!





CONTROL OF APHIDS INJURIOUS TO ORCHARD FRUITS, CURRANT, GOOSEBERRY AND GRAPE

A. L. QUAINANCE

Entomologist in Charge

and

A. C. BAKER

Entomologist, Deciduous Fruit Insect Investigations



**FARMERS' BULLETIN 1128
UNITED STATES DEPARTMENT OF AGRICULTURE**

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief

Washington, D. C.

June, 1920

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APHIDS are small, delicate, winged or wingless insects which feed upon plant juices, draining them from the foliage, fruit, twigs, or roots, through a beak pushed into the plant tissues.

Many kinds injure orchard fruits, currant, gooseberry, and grape. The most important are discussed in this bulletin.

Contact sprays, such as kerosene emulsion, soap washes, nicotine solutions, etc., must be used to kill aphids. Directions for preparing and applying them will be found on pages 39-45.

Stomach poisons, such as arsenate of lead, Paris green, and other arsenicals, are of no use against aphids.

Species which winter in the egg stage on the plants to be protected may be sprayed early in the spring as the buds are expanding, to kill the first brood and insure against injury later in the season.

Leaf-curling species, especially, should be treated with this bud spray in years when they are expected to be abundant. They can not be reached satisfactorily after the leaves have unfolded and the aphids have begun to be troublesome.

Those species which do not curl the leaves may be controlled readily by sprays when they are noted as becoming numerous.

Annual bud spraying in the case of the apple appears to be good orchard practice and, continued for a series of years, doubtless would prove profitable.

CONTROL OF APHIDS INJURIOUS TO ORCHARD FRUITS, CURRANT, GOOSEBERRY, AND GRAPE.¹

A. L. QUAINANCE, *Entomologist in Charge*, and A. C. BAKER, *Entomologist*,
Deciduous Fruit Insect Investigations.

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THE control of aphids, or plant-lice, is an ever recurring problem to the grower of orchard and bush fruits. Although cereal and forage crops furnish perhaps the most striking examples of the destruction wrought by aphids, practically no crop is free from attack by one or more of these small and delicate insects. During the past decade especially, aphid injury to orchard fruits, particularly the apple, has been on the increase.

The present bulletin treats of the aphids injurious to fruit and foliage of apple, quince, pear, plum, cherry, peach, currant, gooseberry, and grape. Forty-one species of aphids in all are discussed. The more important forms affecting a given fruit are considered first, and then follows a brief account of species known to infest the plant locally or occasionally, and which growers should be able to distinguish from the more destructive species. In their life history aphids are peculiar in many respects, and each species occurs in several different forms; for this reason a short account of aphids in general is given for the information of readers not familiar with these facts. Remedial measures are described at the close of the bulletin, since similar treatments are applicable, with some variations, for the control of all the species considered.

¹ Since the well-known grape phylloxera [*Phylloxera vitifoliae* (Fitch)] is injurious principally to the roots and requires control measures radically different from those employed against foliage-inhabiting aphids, it is mentioned only incidentally in this bulletin, although its galls on grape leaves are illustrated (fig. 27, p. 36).

NOTE.—This bulletin is of interest to orchardists, vineyardists, and growers of currants and gooseberries in all parts of the United States.

APHIDS IN GENERAL.

Aphids, or insects of the family Aphididae, have a development which is remarkable in several ways. Eggs laid in the autumn hatch in the spring about the time when vegetation revives. From these winter eggs is produced a generation of females, usually wingless, which reproduce without the intervention of males (agamic reproduction), many species giving birth to living young. The adult aphids of this first generation are termed stem-mothers. The offspring of the stem-mothers (second generation) may be winged or wingless, or both forms may occur. They reproduce without the intervention of males, some species being oviparous, or egg laying, and depositing eggs which do not require fertilization for development, while others are viviparous—that is, they bring forth young alive, the eggs developing and hatching within the body of the parent.

A succession of generations may be produced in this way until the approach of autumn, when the true sexes appear and the females deposit eggs; or a species perhaps may be more or less biennial, some individuals producing true sexes only every second year. In still other species, the true sexes of which are at present unknown, reproduction without the intervention of males continues for a series of years.

The same species of aphid usually exhibits several forms, as wingless agamic females, winged agamic females, and the true sexual forms. In the last the male may be winged and the female wingless, or both sexes may be wingless. The different generations of a given species may vary more or less in appearance, and in some instances this is the case to such an extent that they appear to belong to distinct species.

Aphids feed upon sap which is sucked up through a beak pushed down into the tissues of the plant. Their presence on plants frequently is indicated by a curled and distorted condition of foliage, though this is not always so. When the insects are abundant the drain upon the plant is very great, interfering with its proper growth and development, and in extreme cases causing the death of infested parts. The leaves and shoots of plants infested by aphids are frequently seen to be covered with a black substance, as if dusted with soot. This is due to a black fungus which grows on the "honeydew" excreted by the aphids and is not especially injurious, though often objectionable as marring the appearance of the plants and fruit. Honeydew may be produced in such quantities as to coat the leaves and is attractive to various species of ants and wasps, which are

DESCRIPTION OF PLATE I.

THE ROSTY APPLE APHID: *A*, Infested leaves and young apples, showing characteristic curling of the leaves; *B*, apples at later stage dwarfed and distorted by earlier attack of the aphids; *C*, mature aphid of first generation, pink variety; *D*, winged spring migrants going from apple to narrow-leaved plantain (*E*); *E*, narrow-leaved plantain infested by summer wingless generations; *F*, mature wingless summer aphid on plantain; *G*, fall migrants and males flying from plantain back to apple in fall; *H*, fall migrants and males alighting on apple leaves, the former giving birth to sexual females; *I*, a fall migrant; *J*, male; *K*, sexual female and eggs, the latter yellow at first, later turn black; *L*, twig showing the eggs in winter.

often seen attending the aphids or frequenting plants infested by them. The ants of themselves are not usually the cause of trouble but merely denote the presence of the aphids.

Since frequent reference must be made in the following pages to the different stages and forms of aphids, information concerning these is presented in summary form as far as present purposes require:

Winter eggs.—These are small, oval, and blackish, and occur on the twigs, around buds, under scales of bark, or elsewhere on the shoots or branches of the winter host plant.

Stem-mothers.—The aphids hatching from the winter eggs. They are the progenitors of the numerous generations which follow during the succeeding spring, summer, and fall.

Wingless viviparous females.—Wingless aphids which give birth to living young without the intervention of males.

Winged viviparous females or migrants.—Winged aphids which give birth to living young without the intervention of males and which migrate to other plants, establishing new colonies. *Spring migrants* and *fall migrants* are often to be distinguished.

The true sexes.—Males and sexual females are usually developed in the fall from the viviparous forms, the female depositing eggs to carry the species over the winter.

APPLE APHIDS.

Three or four species of aphids commonly attack the fruit and foliage of the apple, while a few more, which at present are of minor importance, are known to infest this plant. The important species to be considered are the rosy aphis, the green apple aphis, the woolly apple aphis, the apple-grain aphis, and the clover aphis.

THE ROSY APHIS.¹

The rosy aphis infests especially the foliage surrounding the blossom or fruit clusters, and causes the leaves to curl badly. (Pl. I, A; illustration on title page.) The insects when abundant also infest the fruit stalks and newly set fruit. The little apples on the infested fruit spurs often fail to thin out, remain small, and as the season progresses become knotty and distorted according to the degree of infestation. (Pl. I, B.) In the fall these "aphis apples" (fig. 1) may be much in evidence, especially on the lower parts of the tree, during worst aphid seasons amounting to from 15 to 30 per cent of the crop. This species is very generally present in the apple-growing portions of the country and is at present the most important aphid pest attacking the foliage and fruit of this crop. On very young trees the feeding habits differ somewhat in that in addition to the foliage the aphids may attack the young shoots, causing these as they grow to become curled and twisted (fig. 2), resulting in permanent deformities which in pruning must be cut out in order that a properly formed tree may be produced.

¹ *Anuraphis rosae* Baker.

The rosy apple aphid is easily distinguished from the other forms inhabiting the apple by its color. This varies from light salmon pink to deep purple or grayish black. (Pl. I, C.) The young stem-

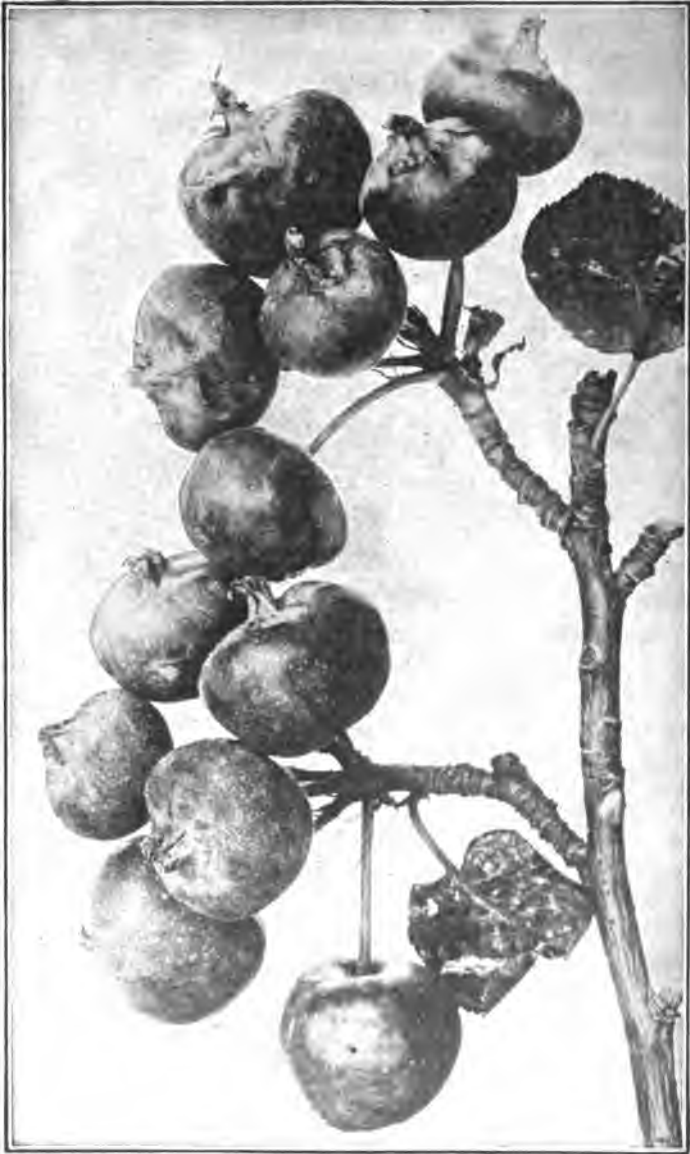


FIG. 1.—The rosy aphid: "Aphis apples." Note that the fruit has failed to thin out in the clusters.

mothers when first hatched from the eggs are dark green, very similar in color to the young stem-mothers of the green apple aphid. The winged forms (Pl. I, I) are dark and often appear almost black, owing to the black head and body and the large black patch upon

the abdomen. This is particularly true of the fall migrants, which appear upon the trees in the fall. These produce the orange-yellow, wingless, egg-laying females (Pl. I, K). The males are winged and similar to the fall migrants. (Pl. I, J.) The summer forms occurring upon plan-tain are yellowish green, with brown patches at the base of the honey tubes.

SEASONAL HISTORY.

The eggs of this species are deposited on the apple in the fall. They are light yellow when laid and change from green to polished black. They are placed upon the twigs, in the axils of the buds, or in crevices in the bark, but sometimes they are laid upon the larger branches. (Pl. I, L.) They begin hatching at about the time the buds are breaking in the spring. (Pl. III.)



FIG. 2.—The rosy aphid: Twisted apple twig resulting from injury by this species.

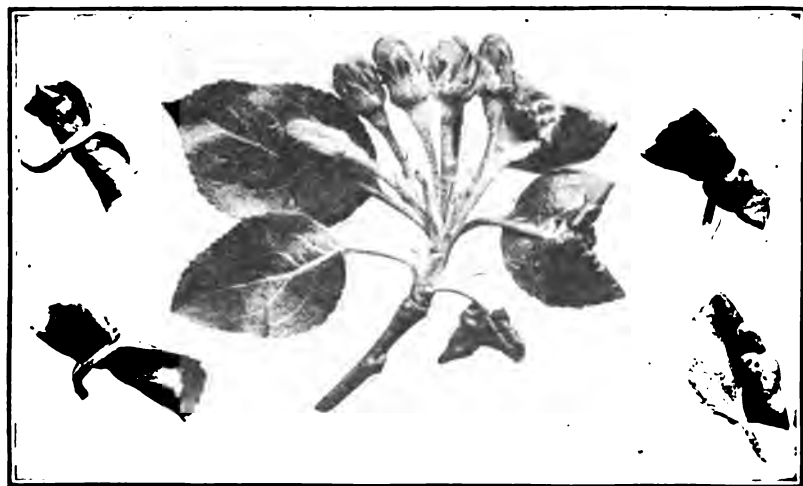


FIG. 3.—The rosy aphid: Condition of the foliage in spring when leaves curled by this insect are first in evidence.

The young stem-mother immediately begins feeding upon the bursting buds, and as the young leaves develop they curl about her. (Fig. 3.) Usually in 15 days the stem-mother is mature, whereupon

she begins producing young at an average of 6 a day. The stem-mother lives from a month to six weeks.

The offspring of the stem-mother may either become winged or remain wingless, and this condition may continue for at least 7 generations, so that during these generations both winged and wingless forms are to be found upon the apple. Occasional colonies of wingless forms may be found throughout the summer upon the apple. The winged forms, however (Pl. I, D), when mature fly to plantains and settle upon the underside of the leaves, or upon the flower stems, where they produce young (Pl. I, I, E). They live principally upon the species known as rib grass, long-leaved plantain, or buckhorn plantain.¹ This migration to the plantains continues, in the vicinity of Washington, from the middle of May until the first part of July. On the plantains the insects continue to reproduce during the summer months. Most of the forms produced on these plants are wingless, although a few winged ones occur throughout the summer. The color of these forms is yellowish green, in contrast to the pink or rosy color of those upon the apple. From 4 to 14 generations of the summer forms occur upon plantain in the vicinity of Washington.

In the middle of September winged forms, consisting of fall migrants (agamic females) and males, begin to appear upon the plantains. These winged forms are able to live and reproduce only upon apple trees or closely related species. The fall migrants leave the plantains and settle upon the underside of the apple leaves (Pl. I, H), where they produce the young egg-laying females. These egg-laying females are wingless and orange-yellow (Pl. I, K). The males, which are similar in color to the fall migrants, often being nearly black, fly from the plantains and find the egg-laying females upon the trees. Here mating takes place and the females deposit their eggs about the middle of October. As later females are produced by later migrants, egg-laying continues until freezing weather has killed all the females.

THE GREEN APPLE APHIS.²

The green apple aphid lives on the apple throughout the year, and infests the tender terminal growth, causing the leaves to curl, as shown in Plate II, J, and figure 4. In young orchards by midsummer the shoots and leaves of the trees may be more or less generally

¹ *Plantago lanceolata*.

² *Aphis pomi* De Geer.

DESCRIPTION OF PLATE II.

THE GREEN APPLE APHIS: *A*, Apple twig in spring with healthy young leaves; *B*, a leaf yellowed by attack of young aphids; *C*, a twig badly infested, showing sickly and stunted opening leaves; *D*, young aphid of first generation; *E*, mature aphid of first generation, a stem-mother; *F*, *G*, young and mature aphids of wingless summer generations; *H*, winged aphid of summer generations; *I*, wingless summer form, side view showing the sucking beak; *J*, terminal shoot of young tree with late summer infestation of aphids; *K*, a leaf from *J* showing aphids and their shed skins on under surface; *L*, a male aphid, produced only in fall; *M*, a sexual female, produced only in fall; *N*, eggs, yellowish when first laid, turning through green to black.

DESCRIPTION OF PLATE III.

GREEN APPLE APHIS ON OPENING APPLE BUDS: Winter eggs and newly hatched aphids on opening apple buds; young aphid much enlarged at right.

infested, often so much so as decidedly to check the growth. Such trees are likely to be more or less sooty in appearance and overrun with ants. Water sprouts and the shoots of top-worked trees are especially liable to attack. This is the species commonly present on the shoots of apple nursery stock, and much complained of during some years. The work of this aphid is at times confused with that of the apple leafhopper,¹ which distorts the leaves in a manner more or less similar.

The green apple aphid is uniformly green, with black legs, feelers, and honey tubes. (Pl. II, E, G, I.) Occasionally forms are met which are yellowish, instead of a distinct green. The winged forms (Pl. II, H) have a black head and body and a uniformly green abdomen. The males and egg-laying females, which are met during the fall, are somewhat smaller and different in color from the agamic forms (Pl. II, L, M) which occur throughout the summer. The males are orange yellow, sometimes with a brownish tinge, and the females dark green.

SEASONAL HISTORY.

The eggs when first laid are yellowish green, later turning to polished black. They are laid in the fall upon the smooth twigs and water sprouts of the apple (Pl. II, C; Pl. III; fig. 5), and seem to be laid rarely on the trunks and larger limbs. A very small percentage of the eggs of this species, sometimes as low as 2 per cent, hatches. Hatching occurs

at about the same date in the spring as in the case of the rosy aphid.

The young stem-mothers mature in about 10 days, and in about 24 hours after becoming adult begin to produce living young, reproduction continuing for about two weeks. Between 40 and 50 living young are produced by each stem-mother, at the average rate of 4 a day, although many more may be born daily. Of these young



FIG. 4.—The green apple aphid: Curled condition of apple foliage due to this insect.

¹ *Empoasca mali* Le Baron.

some develop into winged forms, or migrants (Pl. II, H), and some remain wingless (Pl. II, E, G, I). They mature in a little over a week, and in turn produce either winged or wingless forms. Occasionally another form, intermediate between the winged and the wingless forms, is seen. This reproduction continues throughout the summer, from 9 to 17 summer generations occurring before the sexual forms appear. The true sexes, therefore, appear from the tenth to the nineteenth generation, depending upon the rate of reproduction of their ancestors and upon the time of their birth—that is to say, whether they are early or late young of the parents.

The egg-laying females become adult in from 6 to 16 days, depending upon weather conditions. When adult they mate with the males and begin depositing their eggs upon the apple twigs. Females may be found on the trees until all the leaves have fallen, even when the weather is very cold.

THE APPLE-GRAIN APHIS.¹

The apple-grain aphid, or the apple-bud aphid, has been confused in this country with the oat aphid² or European grain aphid, an insect which is not common here but which occurs in Europe on the bird cherries. Both insects spend the summer on grains and grasses and on these plants look very much alike, but the apple-grain aphid lives during the winter months on apple and not on cherry. It is the earliest apple aphid to hatch in the spring; and as it often occurs in great abundance upon the buds and young foliage, it is frequently the cause of alarm on the part of orchardists. The species probably does not cause important injury, since it migrates from the apple shortly after the blossoms fall. (Pl. IV, A, B, C, D.)

When first hatched the stem-mothers are very dark green, and they remain this color until after the first molt, when they become much paler. The adult wingless forms are pale green (Pl. IV, E), with rusty areas around the base of the honey tubes, although in the summer some individuals become slightly purplish. The winged forms have black head and body with a green abdomen which is marked with black patches along the sides. (Pl. IV, F.) The honey tubes, antennæ, and feet are black. The egg-laying females, which occur in the fall, have an olive cast. (Pl. IV, N.)

SEASONAL HISTORY.

During warm days in winter many of the eggs of this species hatch on the trees, but it is not until about the middle of March, in the vicinity of Washington, that those hatching succeed in escaping destruction and produce stem-mothers. In fact, aphids from eggs hatched before April 1 are sometimes all killed by cold. The important hatching, therefore, commences after April 1.

¹ *Rhopalosiphum prunifoliae* (Fitch).

² *Rhopalosiphum padi* (L.) (*avenae* Fab.).

The young stem-mothers of this species usually are abundant upon the swelling apple buds (Pl. IV, A), and when these begin to open the insects crowd down among the bursting leaves. By the time the stem-mothers are adult—usually in about 13 days—many of the buds have opened and the leaves expanded. Each stem-mother produces about 100 young, and these migrate to the blossoms and to the underside of the leaves, which become coated with them. (Pl. IV, D.) These young may become either winged or wingless adults (Pl. IV, E, F), and at least four generations may be produced upon the apple. The wingless forms upon apple become mature in about seven days, and each individual produces about 75 young. The period of reproduction lasts a little over two weeks, and the insects live about a month.

The winged forms produced upon apples become mature in a little over 8 days and then fly to grain and grasses, as wheat, oats, etc. (Pl. IV, G, H, O.)

In the autumn migrants are produced on grains. (Pl. IV, L.) These mature in about 2 weeks and return to the apple, the migration lasting 3 or 4 weeks, since not all the migrants are produced in the same generation. (Pl. IV, J, L.) During their life of some 6 weeks these migrants produce about 5 egg-laying females each.

The winged males are produced upon the summer food plants and migrate to the apple leaves to mate with the sexual females. (Pl. IV, M, N.) After the female has become fertilized she deposits her eggs in crevices of the bark of the larger branches or behind the bud scales of the young twigs of the apple. (Fig. 6.) The length of life of each sex depends upon weather conditions. This is particularly true of the female, which sometimes lives for weeks in a more or less dormant state during cold weather. In warm climates the species may hibernate as wingless females upon the summer hosts.



FIG. 5.—The green apple aphid: Winter eggs on apple twig. Much enlarged.

THE CLOVER APHIS.¹

The clover aphid, first found injurious to the apple in Colorado, is now known to occur abundantly in some regions in the East. It attacks the apple in a way similar to the green apple aphid, but since there is a considerable migration of individuals to clover, it is less abundant on the apple in summer than the latter species. The stem-mothers of the clover aphid are pink and the individuals of the next generation are yellowish green. The winged forms have a large black patch on the abdomen and in this way resemble the migrants of the rosy aphid. The two species, however, can be distinguished readily by the length of the honey tubes. In the rosy aphid these are very long, while in the clover aphid they are short. The forms of this species which live on clover are pink. (Fig. 7.)



FIG. 6.—The apple-grain aphid: Winter eggs on bark of apple tree. Much enlarged.

SEASONAL HISTORY.

The eggs of the clover aphid are laid upon the apple in much the same manner as those of the species already mentioned. The stem-mothers, which are hatched considerably earlier than those of the rosy aphid and the green apple aphid, give birth to winged and wingless forms, which in turn produce young, some of which become winged, while the others remain wingless. As a rule most of the insects have become winged by early summer, although some wingless colonies occur during the summer on apple. These winged forms fly to clovers, and settling upon the stems produce wingless young. These and succeeding generations, which may contain winged individuals, pass down to the crown of the clover plants, and here the species lives throughout the summer. During October numerous fall migrants are produced upon the clovers and fly to the apple, where they give birth to the young egg-laying females. Winged males produced upon the clovers follow the fall migrants to the apple, and here mate with the females, which later deposit their eggs.

¹ *Anuraphis bakeri* (Cowan).

DESCRIPTION OF PLATE IV.

THE APPLE-GRAIN APHID: *A*, Opening apple bud in spring infested with young aphids. The empty egg shells are seen still adhering to the twig; *B*, young aphids, more enlarged; *C*, the leaves unfolding in the bud; *D*, infested blossoms; *E*, a full-grown aphid of the first generation from the blossoms (*D*); *F*, a winged aphid, or spring migrant, from the next generation on the apple leaves; *G*, flight of spring migrants from apple to grain (*H*); *H*, oats infested by summer generations of aphids which are mostly wingless; *I*, wingless summer form; *J*, flight of fall migrants and males from grain back to the apple (*K*); *K*, fall migrants and males alighting on apple leaves, the fall migrants giving birth to the sexual females; *L*, a fall migrant; *M*, a male produced on apple in fall; *N*, sexual females showing extreme color varieties, and eggs which are pale when laid, but later turn black; *O*, wingless aphids that remain about the roots of the grain when the winter is not too severe.

THE WOOLLY APPLE APHIS.¹

The woolly apple aphid is often in evidence in summer on the trunk, branches, and twigs of the apple as bluish-white cottony patches (fig. 8) which hide the rusty or purplish brown aphids beneath. While principally injurious to the roots of the apple, its injuries above ground are at times quite important. In orchards grown under arid or semi-arid conditions in the West it is decidedly more troublesome than in the East, attacking the tree wherever the bark is tender and sometimes infesting the stems of the leaves and fruit. Its injuries above ground often result in galls or swellings similar to those on the roots, and when the fruit spurs are invaded the fruiting capacity of the tree may be interfered with seriously.

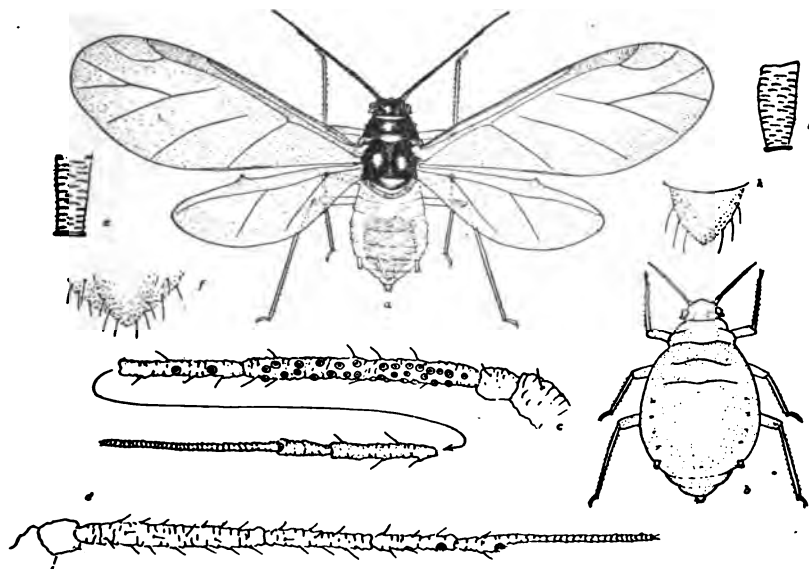


FIG. 7.—The clover aphid: a, Spring migrant; b, stem mother; c, antenna of spring migrant; d, antenna of wingless form; e, cornicle of spring migrant; f, cauda of spring migrant; g, cornicle of wingless form; h, cauda of wingless form. a, b, Much enlarged; c-h, more enlarged.

The usual contact sprays will be effective in destroying this pest on the limbs and branches. Its treatment on the roots of the apple requires essentially different methods, which are not considered in this bulletin.

APPLE APHIDS OF MINOR IMPORTANCE.

Several additional species of aphids are found upon the apple, but these are at present of minor economic importance.

The potato aphid² has been found feeding upon the apple occasionally in the spring. Its normal winter host appears to be the rose. This form is very much larger than the others mentioned, and the winged form, as well as the wingless one, is uniformly light greenish.

¹ *Eriosoma lanigerum* (Hausm.).

² *Macrosiphum solanifolii* (Ashm.).

Another species, which is slaty blue or black, with white bands upon the legs, and often possesses white waxy tufts, occurs sometimes upon the apple. This is the dock aphid.¹ The apple does not seem to furnish suitable food to these insects, for after a few generations they always leave the trees.



FIG. 8.—The woolly apple aphid: Colonies on apple shoots.

A second dark brown or blackish species which occurs occasionally upon the apple is the bur-clover aphid.² It is sometimes encountered during the spring upon apple foliage.

Still another species, the wild-carrot aphid,³ occurs commonly on the apple in the fall, particularly as the winged form. Its summer hosts are the wild carrot and related plants, and the winged forms fly to honeysuckle vines, but occasionally select apple trees.

The thorn-leaf aphid⁴ also is found occasionally upon the apple. Its life history is discussed under aphids attacking the quince.

QUINCE APHIDS.

Two species of aphids which have been discussed under apple occur commonly also upon quince foliage—namely, the green apple aphid and the apple-grain aphid. Their life histories are similar on quince and apple, and the same remedial measures apply.

THE THORN-LEAF APHIS.

The thorn-leaf aphid,⁴ called also the long-beaked clover aphid, is most common upon hawthorn trees. Although first found upon thorn, it is not uncommon upon quince leaves. It resembles very closely the clover aphid as found

upon apple, but can be distinguished from that insect by its long beak.

On thorn trees the feeding of this species results in a curling of the leaves which is very conspicuous, the twisted leaves taking on a purplish cast. On quinces, however, it does not curl the leaves, or at least not to such an extent.

¹ *Aphis rumicis* L.
² *Aphis medicaginis* Koch.

³ *Hyadaphis zylotsei* (Schränk).
⁴ *Anuraphis crataegifoliae* (Fitch).

SEASONAL HISTORY.

The eggs of this insect are laid in the fall upon the twigs of the quince, and the stem-mothers hatch in the early spring. By early summer the insects are abundant and winged forms are being produced. This production of winged forms, or migrants, continues until late summer. The migrants fly from their winter hosts to clovers and peas and produce numerous generations on these plants in a manner very similar to that of the clover aphid. In the fall, migrants are produced which return to the quinces and produce the egg-laying females, which after mating with the males deposit the winter eggs. The flight of the insects from clover begins in September and extends throughout October.

PEAR APHIDS ATTACKING THE FOLIAGE.

Several species of aphids are found upon pear foliage. Most of these, however, occur also upon other trees and are treated elsewhere in this bulletin. The more common forms upon pear are the green apple aphid, the apple-grain aphid, and the clover aphid.

Another species, the woolly thorn aphid,¹ is common in some localities. Both winged and wingless forms are covered with a white, waxy substance. The wingless forms are pale green and the winged forms have a black head and body. The insects hatch in the early spring and soon attack the leaves, curling and twisting them. During early summer the winged forms leave the pear tree. In the fall migrants may be found again, and these produce the sexual forms, the females of which lay their eggs upon the bark. Besides attacking pear, this species occurs upon thorn, quince, and Juneberry.

Two other forms are found commonly upon pear, but these occur upon the roots, and since they are seldom found upon the branches and foliage and require different remedial measures, they are not treated in this bulletin. The first of these is the woolly pear aphid,² which is common in the western part of the country, and the second is Fitch's pear root-aphid,³ which is very similar to the woolly thorn aphid and occurs in the eastern United States.

PLUM APHIDS.

Three or four species of aphids are common on the plum, two of which are, during some seasons, very injurious. Many complaints of injury to Japanese and native plums by the rusty plum aphid have come from the more southern States, while the mealy plum aphid is more often prevalent in the North and West, on Domestic, or the European type of plums. The hop aphid, according to records of the Bureau of Entomology, has not occasioned much injury to plums in recent years, although in the Pacific Northwest it continues to be a pest of importance to hops.

¹ *Prociphilus corrugatus* (Serrine).

² *Eriosoma pyricola* B. & D.

³ *Prociphilus fitchi* B. & D.

THE RUSTY PLUM APHIS.¹

The rusty plum aphid was discovered and named from individuals feeding on grass, but is better known by its injuries to plums. It is rusty brown or deep purplish, with white bands upon the legs.

This species feeds upon the tender twigs and foliage of the plum and also upon the peach. The first stem-mothers attack the buds just as they are expanding in the spring and later crawl down among the opening leaves. As the season advances whole twigs or small branches may be literally crowded with the aphids (fig. 9), and such twigs usually die. Another species, not yet named, also has this habit, and this form may be very injurious to the twigs, as it remains on the plum throughout the summer.



FIG. 9.—The rusty plum aphid: Colony on shoot and foliage of plum.

SEASONAL HISTORY.

The eggs of the rusty plum aphid hatch early in the spring and the normal life period of the stem-mother is about a month. During this time she produces young at the rate of four to six a day. In a little over a week these young are mature and reproducing, so that large colonies soon result. A few winged forms occur in the early generations, but it is not until late spring that a large percentage of spring migrants is found. These winged forms fly from the plum and settle upon various grasses, where they produce colonies throughout the summer around the crowns of the plants. In October the fall migrants are produced upon the grasses, return to the plum, and there give birth to the egg-laying wingless females.

The males also produced upon the grasses, migrate to the plum in order to locate and fertilize the egg-laying females. In some regions the species seemingly lives on the plum throughout the year.

THE LONG-BEAKED THISTLE APHIS.¹

In some localities the long-beaked thistle aphid is abundant on plum trees. In structure this species most closely resembles the rusty plum aphid. The insects are shiny green and black, some of the wingless ones and all of the winged ones having a large black patch on the abdomen. (Fig. 10.)

Although this species becomes very abundant on the trees, it does not curl the leaves to any extent. Trees have been observed in the vicinity of Washington with the underside of nearly every leaf thickly covered with the insects, and yet these leaves were rolled only slightly from the edges. The insects always feed on the underside of the leaves or on the very tender twigs. Practically all the injury done to the trees is by the spring forms, the fall migrants being scattered.

SEASONAL HISTORY.

The eggs of this species are laid upon the plum, as are those of the rusty plum aphid. In the early spring the stem-mother hatches and gives birth to living young. Winged forms begin to appear as early as the second generation and continue to be produced until midsummer. These migrate to thistles, where they produce the first of the summer forms. After having produced numerous generations on the thistle during the summer, fall migrants are produced which return to the plum trees to deposit the young egg-laying females. These, after being fertilized by the males, lay the winter eggs.

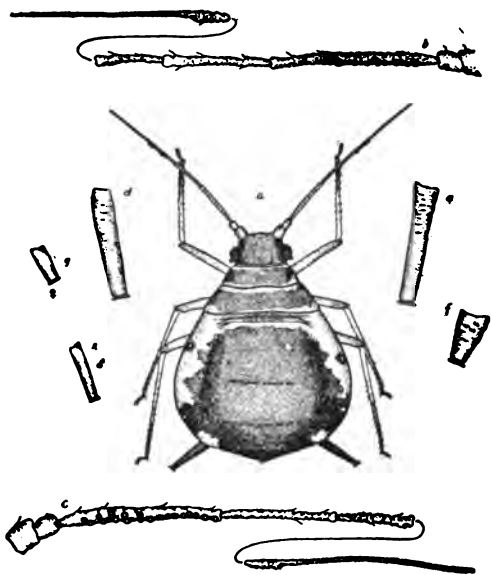


FIG. 10.—The long-beaked thistle aphid: a, Wingless female; b, antenna of spring migrant; c, antenna of fall migrant; d, cornicle of fall migrant; e, cornicle of spring migrant; f, cornicle of stem mother; g, cornicle of egg-laying female; h, cornicle of male. a, c, Much enlarged; b-h, more enlarged.

THE WATER-LILY APHIS.²

Plum trees are sometimes thickly infested by an aphid with swollen honey tubes, the water-lily aphid. The insects are brownish, the winged forms having a black head and body.

¹ *Auraphis cardui* (L.).

² *Rhopalosiphum nymphaeae* (L.).

The spring forms feed upon the underside of the leaves or on the tender twigs of the plums, but they do not curl the leaves to any extent. The summer feeding habits of the species on water plants are very interesting, as colonies often are partially submerged for some time without apparent injury.

SEASONAL HISTORY.

The stem-mothers of this species hatch early in the spring upon the plum, and soon the young produced cover the lower side of the leaves and the twigs. Winged forms are found during June and these fly to various water plants, on which they reproduce and live during the summer months. In the fall the migrants return to the plum and produce the egg-laying females, which, when adult, are fertilized by the winged males. The flight of the fall migrants and males extends over a long period, the males having been found on the plum trees from early until late fall.

THE HOP APHIS.¹

A large green aphid, the hop aphis, is in some regions very common upon plums in the spring. The wingless forms are light green and the winged forms are light green with black head and body and a patch of the same color on the abdomen.

The stem-mothers of this species feed upon both the flower buds and the leaf buds of the plum. After the leaves have expanded, the insects attack the underside of the leaves and often may be found thickly crowded thereon.

SEASONAL HISTORY.

The eggs hatch on the plum twigs considerably later as a rule than those of the thistle aphis. The young stem-mothers soon develop and begin the production of young. Winged forms soon appear, the greater number of these occurring in the third generation. These winged forms fly to hop vines, where they produce young that feed upon the hop plant. Eight or more generations of these summer forms are produced upon the hop, and winged fall migrants are then produced, which return to the plum trees to produce the sexual females. Males appear during the fall for a period of several weeks, the last ones usually occurring late in October or in November. These fertilize the egg-laying females, which then lay their eggs upon the twigs.

In some cases the species is able to complete its life cycle on the hop and does not necessarily alternate with the plum, whereas in other cases it remains all summer upon the plums.

¹*Phorodon humuli* (Schrank).

THE MEALY PLUM APHIS.¹

The mealy plum aphid is a common form on plum trees and it can be distinguished from the other species attacking plum foliage by its uniform green color and the fine, white, powdery covering of the body. The honey tubes also differ in that they are very short.



FIG. 11.—The mealy plum aphid: Infested plum foliage.

SEASONAL HISTORY.

These insects feed upon the underside of the leaves, often being very closely packed together. (Fig. 11.) As a rule they do not curl the leaves, even when present in great numbers.

The stem-mothers of this species hatch from the winter eggs on the plum early in the spring and in about 10 days they are mature.

¹*Hyalopterus arundinis* (Fab.).

They then give birth to young, and these when grown produce others until the leaves are often thickly covered with the insects. Winged forms develop toward late spring and continue to appear until late midsummer or later. These winged forms migrate to certain grasses and produce numerous generations during the summer. In the fall return migrants are produced, which give birth to the egg-laying forms on the plums. These migrants first appear in early September, but continue to arrive until late October or early November.

THE HAWKWEED APHIS.¹

The hawkweed aphid is a native of Europe, where it lives on plums. In India it is very injurious to peaches and is there known as the

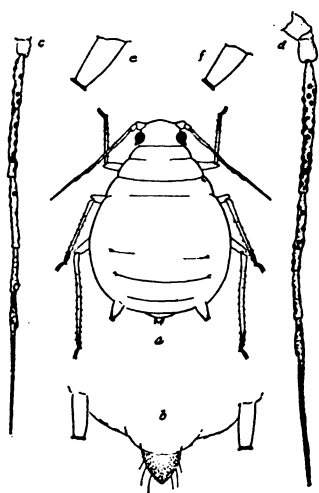


FIG. 12.—The hawkweed aphid: a, Wingless form from plums; b, cornicles of the spring migrant; c, antenna of summer winged form; d, antenna of spring migrant; e, cornicle of summer wingless form; f, cornicle of spring wingless form. a, Much enlarged; b-f, more enlarged.

peach-curl aphid. It has recently been found in numbers in our western region on plums. The winged forms have a black head and thorax and a green abdomen with a large black patch on it. The honey tubes are short. The wingless forms are green. (Fig. 12.)

SEASONAL HISTORY.

The eggs are laid upon plum trees and in the spring hatch to the greenish stem-mothers. These produce wingless forms and in late spring the winged ones may be found. These winged ones migrate to hawkweed, scorpion-grass, groundsel, etc., and produce summer colonies on these plants. In the fall winged migrants return to the plums and deposit the wingless egg-laying females. The winged males follow and mating takes place on the plums, peaches, etc. In this country the insect

has not been found to be injurious to peaches, but it may become so in time.

CHERRY APHIDS.

THE BLACK CHERRY APHID.²

The black cherry aphid is an abundant species almost everywhere upon cherry trees. The wingless insects have a rounded abdomen, which gives them a more or less globular appearance. Both wingless and winged forms are shining deep brown to black, while the

¹ *Anuraphis helichrysi* (Kalt.).

² *Myzus cerasi* (Fab.).

color of the young ranges from amber through various shades of brown. The young stem-mothers are deep greenish.

On account of their early hatching in spring the young stem-mothers do not find leaf food available. They therefore attack the buds even before these show any signs of bursting. Sometimes



FIG. 13.—The black cherry aphid: Curled terminal cherry leaves following attack by this species.

the stem-mothers will feed in this manner for nearly a week before the buds begin to open. As soon as the leaves are formed the young insects attack them and cause them to curl. As they spread from leaf to leaf a large and conspicuous cluster of curled-up leaves (fig. 13) is formed, within which the insects feed.

SEASONAL HISTORY.

The eggs are laid upon the cherry twigs in the fall and hatch early in the spring. The insects are able to withstand freezing

weather, and after the return of warmer weather continue their activities. Within two or three weeks after hatching the stem-mothers are mature and produce young. These later generations become adult usually in less than a week. Some of the insects so produced become winged while others remain wingless.

The winged forms migrate to pepper-grass and other related plants and here they form colonies throughout the summer. The number which migrate varies in different parts of the country. In some regions there is a very distinct and complete migration, while in other places the wingless forms remain.

The wingless ones continue reproduction, and sometimes give rise to as many as 11 generations before the end of July. The numbers on cherry, however, gradually diminish, and during midsummer very

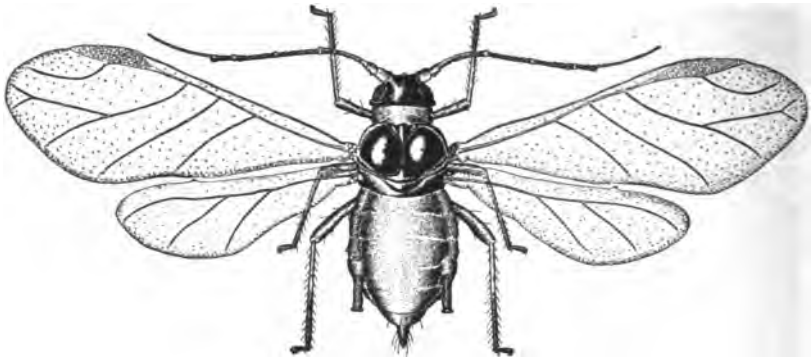


FIG. 14.—The chokecherry aphid: Spring migrant. Much enlarged.

few are seen upon the trees, and in some cases no insects can be found upon trees which earlier in the season were badly infested. During October fall migrants and winged males may be found returning to cherry trees and are often encountered during the migration period in larger numbers than might be expected. The fall migrants produce the egg-laying females which, when mature, are fertilized by the males.

THE CHOCKECHERRY APHIS.¹

The chokecherry aphid is found abundantly upon chokecherries and related trees. It is a pale green insect and is conspicuously mealy. The winged forms have a black head and body.

The feeding habits of this species are very similar to those of the black cherry aphid. The leaves of the terminal twigs are attacked and twisted by the feeding of the insects, entire twigs sometimes being destroyed.

¹ *Aphis cerasifoliae* Fitch.

SEASONAL HISTORY.

As in the case of the black cherry aphid, the eggs of this insect are laid on the cherry twigs. After the stem-mothers have become mature and produced young, these latter crowd the terminal leaves. Winged forms (fig. 14) are produced during early summer, and by mid-summer the insects usually have disappeared from the trees. The winged forms migrate to grains and grasses and here produce colonies which are very similar to those of the apple-grain aphid. Here they live throughout the summer, and in the fall winged forms return to the cherry trees to deposit the egg-laying females.

THE CHOKECHERRY-GRAIN APHIS.¹

The chokecherry-grain aphid is very similar indeed to the oat aphid of Europe and it is not improbable that it is the same species. The wingless forms (fig. 15) are a dark olive green, irregularly mottled with a darker color and dusted with a whitish powder, especially along the sides of the abdomen and in the abdominal wrinkles. The winged forms have the head and thorax shiny black, and the general body color dark olive with black markings on the abdomen and black honey tubes. The pupa, which later becomes the winged form, has powdery tufts along the sides and across the hind part of the abdomen. The insect attacks the terminal twigs of the chokecherry and causes a twisting and curling of the leaves. (Fig. 16.)

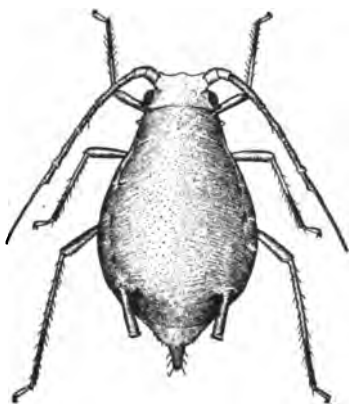


FIG. 15.—The chokecherry-grain aphid: Summer wingless form. Much enlarged.

SEASONAL HISTORY.

The complete life history has not been worked out. Undoubtedly the eggs are laid upon the cherry and hatch to stem-mothers, which with their young cause the curling of the leaves. Winged forms appear in June and continue to be produced for some weeks. These migrate to grains and produce colonies there somewhat similar to those of the apple-grain aphid. On the grains, however, the insects do not possess the mealy covering seen on the cherry forms. In the fall migrants return from the grains and grasses to the cherry and here produce the oviparous females which lay the overwintering eggs.

THE RED AND BLACK CHERRY APHIS.²

The red and black cherry aphid lives in dense red masses on the young shoots of the black cherry. It does not attack the leaves, but

¹ *Rhopalosiphum pseudoavenae* (Patch).

² *Aphis tuberculata* Patch.

confines itself to the shoots. The species has been recorded only from Maine. In colonies found on wild cherry in the District of Columbia a few insects have been seen along the midrib of the leaf. The wingless forms have a light red body dusted with a whitish powder. The legs, honey tubes, and some spots along the sides of the abdomen are black. The winged forms have the head and thorax black and the abdomen red. The life history is unknown.



FIG. 16.—The chokecherry-grain aphid: Work on chokecherry leaves. (Maine Agricultural Experiment Station.)

THE SMALL CHOKECHERRY APHIS.¹

A very small species lives on the chokecherry in Maine. It resembles the apple-grain aphid in appearance, except for the fact that the honey tubes have no swelling. Its life history is unknown.

¹ *Aphis furcata* Patch.

PEACH APHIDS.

THE GREEN PEACH APHIS.¹

The green peach aphid is a common form upon peach trees. The stem-mothers in spring, as well as the fall egg-laying females, are often pinkish, and at other times light green. The wingless agamic form also is light green, while the winged individuals have a black head and body and a large dark-brown patch on the abdomen. This marking occurs upon both the spring migrant and the fall migrant. They are similar in other respects, excepting that the fall form has the honey tubes somewhat swollen.

On the peach this species feeds entirely upon the leaves, on which the insects may be found in large numbers crowded on the underside. (Fig. 17.) It has a large number of other food plants, including numerous garden vegetables.



FIG. 17.—The green peach aphid: Colony on underside of peach leaves. Much enlarged.

SEASONAL HISTORY.

The eggs of this aphid are laid upon the peach twigs, and early in the spring before the buds are opened the green stem-mothers are hatched. From this form during the spring may be produced one or more generations of wingless individuals upon the leaves. Spring migrants, however, begin to occur very early and continue to appear until the middle of June. These fly to a large number of different plants, where numerous generations occur throughout the summer. During September and October fall migrants are developed which return to the peach, where they deposit the young egg-laying females. These are fertilized by the winged males, which also have returned to the peach, and the females then lay their eggs upon the twigs. Occasionally, however, migrants are found which do not return to the peach, and these deposit egg-laying females upon the summer host plants.

¹ *Myzus persicae* (Sulz.).

THE BLACK PEACH APHIS.¹

The well-known black peach aphid is injurious to the twigs, shoots, and roots. It is shiny dark brown to black, with the young an amber color.

The insect lives throughout the year on the roots of the peach and is most injurious to peach growing on sandy soils. It is prevalent in portions of Maryland and in Delaware, New Jersey, and Michigan. Individuals migrate from the roots during the warm periods in winter or in early spring and start colonies on the twigs and young shoots. (Fig. 18.) Often these become so numerous as to cause the death of dormant-budded nursery trees (fig. 19) and do serious or fatal injury to young orchard trees. In mild climates the insects may exist all winter on the twigs, reproducing during periods of warmth, though the twigs are for the most part re-infested each year from the insects below the soil.



FIG. 18.—The black peach aphid: Colonies on peach shoot in early spring.

The complaints of serious injury by this species on the roots of orchard peach trees, in the experience of the writers, have not been justified, the unthrifty condition of the trees being in most cases due to other causes.

SEASONAL HISTORY.

The complete seasonal history of this species is not known. The number of young produced by a given parent varies greatly, depending upon weather conditions. Sometimes only one young aphid a day will be produced, with a total of 25 or 30 young to a mother, while under favorable conditions as many as 12 young

¹ *Anuraphis persicae-niger* (Smith).

may be produced in a day and considerably over 100 as the total for a given parent. In spring large numbers of winged forms (fig. 20) appear and the percentage of these gradually increases until all



FIG. 19.—The black peach aphid: Injury to dormant-budded peach nursery stock in the spring.

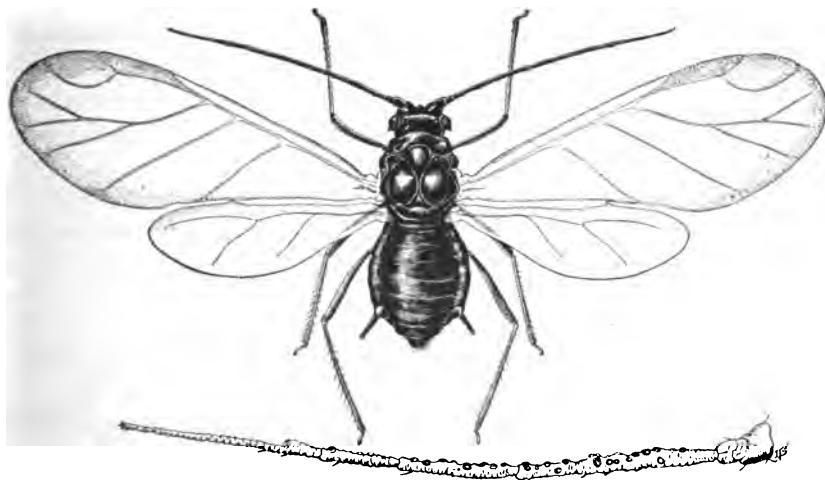


FIG. 20.—The black peach aphid: Above, winged form, much enlarged; below, antenna of winged form, more enlarged.

of the forms above ground have become winged. These fly to some plant or plants not known and are not met on peach foliage until the next year.

THE EUROPEAN PEACH APHIS.¹

The European peach aphid (fig. 21) is one of the chief insect pests of the peach in certain parts of Europe. In this country it has been found so far only in New England. It resembles our black peach aphid in many details, but the honey tubes are much shorter



FIG. 21.—The European peach aphid: *a*, Wingless form; *b*, cornicle of winged form; *c*, antenna of winged form. *a*, Much enlarged; *b*, *c*, more enlarged.

and the coloring is quite different. The general color is a rusty yellow or even a pinkish and the wingless form has a row of dark brown dots along each side and a large black patch on the abdomen. This patch is, however, very often broken up into distinct transverse bands. The young are yellow.

SEASONAL HISTORY.

The eggs are laid upon the peach twigs and the young stemmothers attack the foliage. Wingless and winged forms are produced and these reach their maximum number during late spring. During late summer their numbers diminish and in the fall wingless egg-laying forms and winged males are produced.

THE VARIABLE PEACH APHIS.²

The variable peach aphid is a pale yellow or green and black form which looks somewhat like the green peach aphid. It occurs in California and sometimes severely injures peach trees. Colonies are formed on the tender terminal twigs and the leaves are rolled up tightly by the attacks of the insects. (Fig. 22.) Such leaves take on a reddish tinge and suggest leaf-curl. Inside of the curled leaves, however, can be found large numbers of the aphids.

The life history has not been fully worked out, but the insect is found throughout the spring and summer on clematis, which may be its normal food plant.

CURRANT AND GOOSEBERRY APHIDS.

THE CURRANT APHIS.³

The currant aphid is distributed over the entire country and its injury, on account of its conspicuousness, is the occasion of much complaint. The insect causes the terminal leaves to become much distorted, and little pits or pockets are formed on the underside. (See fig. 23, *b*; fig. 24.) The upper surface of the leaves assumes a

¹ *Anuraphis prunicola* (Kalt.).

² *Myzus varians* Davidson.

³ *Myzus ribis* (L.).

more or less reddish color, evident some distance away. When the plants are badly infested these leaves fall and the fruit becomes poor and ripens prematurely. Red currants are most subject to attack, but black currants and gooseberries also are injured.



FIG. 22.—The variable peach aphid: Work on peach. (Essig.)

The stem-mothers of the species are green, the other wingless forms (fig. 23, *a*) a yellowish green, while the winged ones have a black head and body and a large black patch on the abdomen. The eggs are polished black.

SEASONAL HISTORY.

The stem-mothers hatch from the eggs in the early spring soon after the leaves open. After completing their growth they produce young aphids which infest the lower surface of the leaves. Some of the offspring of the stem-mother are winged and these fly to mother-

worts, hedge-nettles, and related plants. Here colonies develop during the summer, augmented by winged forms produced in other generations on the currants. The wingless ones remain upon the currants and continue reproduction. In each generation some winged forms occur, but wingless individuals are present until late in July upon the bushes. In fact, occasional colonies remain throughout the summer. In the fall, during early October, migrants return to the currant bushes and deposit the sexual females. These when mature are fertilized by the winged males and the eggs are laid upon the twigs.

THE SOW-THISTLE APHIS.¹

The sow-thistle aphid is at times quite as abundant on currants as is the currant aphid. It is somewhat similar in color but can be distinguished at once from the currant aphid by the swollen honey tubes. (Fig. 23, c.) In the currant aphid these are long and very slender. (Fig. 23, a.) The eggs are polished black. The sow-thistle aphid injures the currant in about the same way as does the currant aphid, though the infested leaves (fig. 23, d) do not take on a reddish coloration.

SEASONAL HISTORY.

The seasonal history of this species upon currants is very similar to that of the currant aphid. The winged forms, however, migrate to the sow thistle and upon this they reproduce. After the production of numerous generations here during the summer, fall migrants are developed which return to the currants. Egg-laying females are then produced and these are fertilized by the winged males. The eggs are laid upon the twigs at about the same time as those of the currant aphid.

THE GREEN CURRANT APHIS.²

A species which may be called the green currant aphid has for years occurred with the currant aphid, which it resembles closely. The wingless forms of the present species are green, whereas those of the currant aphid are yellowish. The life history, so far as is known, is very like that of the currant aphid and the two forms often may be found on the same leaf. In fact, it is not improbable that the green currant aphid is merely a dimorphic form of the currant aphid.

THE VARIABLE CURRANT APHIS.³

The variable currant aphid is one of the most injurious species. The stem-mother is purplish green with white honey tubes. The wingless form is dark green, tan, or dark brown, whereas the winged

¹ *Amphorophora lactucae* (Kalt.).

² *Myzus dispar* Patch.

³ *Aphis varians* Patch.

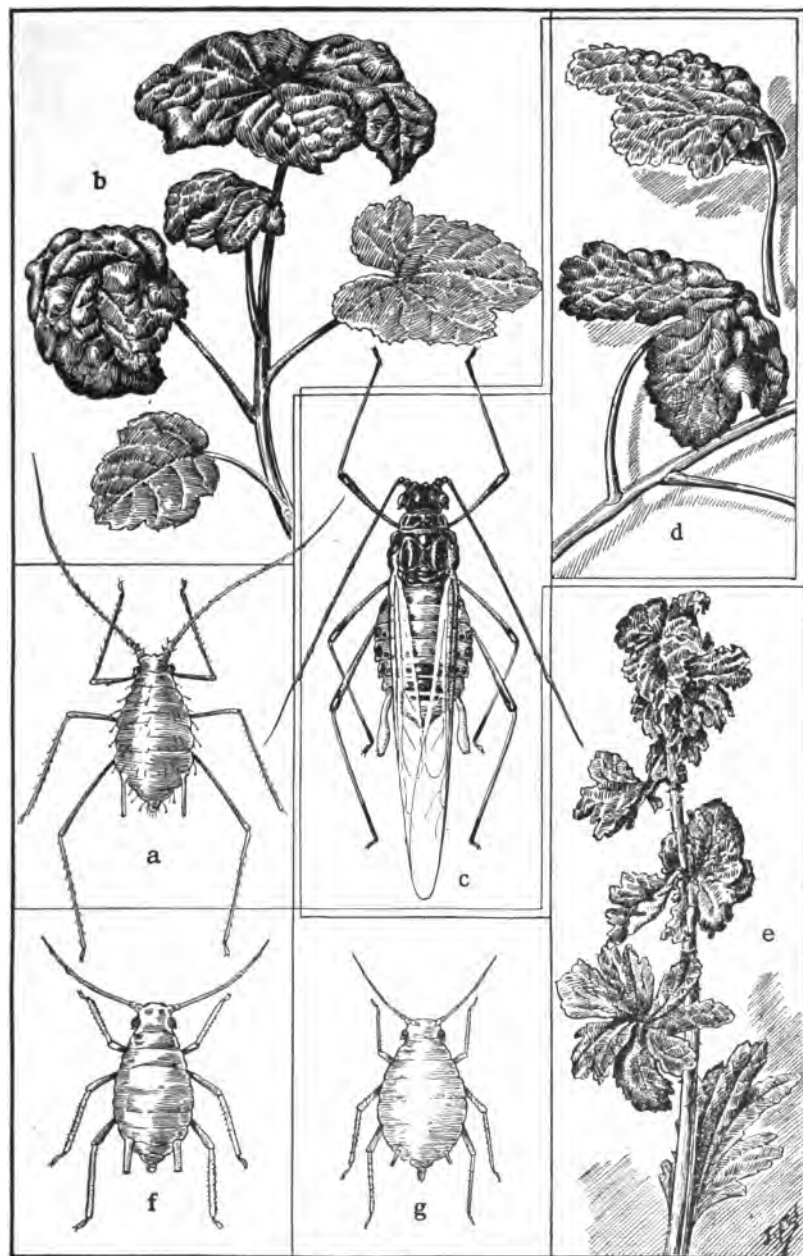


FIG. 23.—Current aphids: *a*, Wingless viviparous female of the current aphid; *b*, distorted current foliage due to attack of this species; *c*, spring migrant of the sow-thistle aphid; *d*, injury to currant by this species; *e*, work of the green gooseberry aphid on gooseberry; *f*, wingless viviparous female of the New Mexico gooseberry aphid; *g*, wingless viviparous female of Sanborn's currant aphid. *a, c, f, g*, greatly enlarged.

form has a black head and body, with a dark green abdomen marked near the tip and on the sides with black.

As soon as the stem-mother begins to feed, the young leaf begins curling about her. As young are produced other leaves are attacked until large irregular bunches of twisted leaves occur. Later the insects attack the shoots, sometimes thickly covering them. The species infests currants, gooseberries, and flowering currants.



FIG. 24.—The currant aphid: Injury to currant foliage.

SEASONAL HISTORY.

The stem-mother hatches from the eggs early in the spring and becomes mature early in May. She produces young which are all wingless. These in turn produce young which may or may not be winged. The winged ones take flight to some unknown summer host, while the wingless ones continue the infestation upon the currants until nearly midsummer. In the fall migrants return to the currants and produce young which develop into males and egg-laying females, the latter depositing eggs upon the twigs.

THE GREEN GOOSEBERRY APHIS.¹

The green gooseberry aphid is a green species with white honey tubes. It lives upon the underside of gooseberry leaves, which it deforms badly (fig. 23, *e*), and also upon the twigs.

The seasonal history of this species has not been determined. The winter eggs are laid upon the host plant upon which the stem-mother develops. Wingless forms occur later than the stem-mother, and winged ones also are produced upon the gooseberry.

THE NEW MEXICO GOOSEBERRY APHIS.²

Another species is found on gooseberries in New Mexico. The wingless forms (fig. 23, *f*) are green, while the winged forms have black head and body, with green abdomen marked with some dark bands or spots. Its life history is unknown. A variety of this species is found in California, feeding upon the red currant.

SANBORN'S CURRANT APHIS.³

A small species of aphid occurs in the Middle West and Southwest on Missouri gooseberries and cultivated currants. This is Sanborn's currant aphid. The wingless forms (fig. 23, *g*) are green, and the winged forms have black head, body, legs, honey tubes, and an-



FIG. 25.—The Houghton gooseberry aphid: Work on Houghton bushes.

¹ *Aphis sanborni* Patch.

² *Aphis neomexicanus* (Ckll.).

³ *Aphis ribis* Sanborn.

tennæ. The species is found in the spring in rather large colonies on the underside of the leaves, which it causes to curl and twist.

THE HOUGHTON GOOSEBERRY APHIS.¹

A pale green species has become prominent in recent years by reason of its attacks on gooseberries. The wingless ones are green and covered with knobbed hairs. The winged ones are dark green with a brown head and thorax. The insects attack the growing

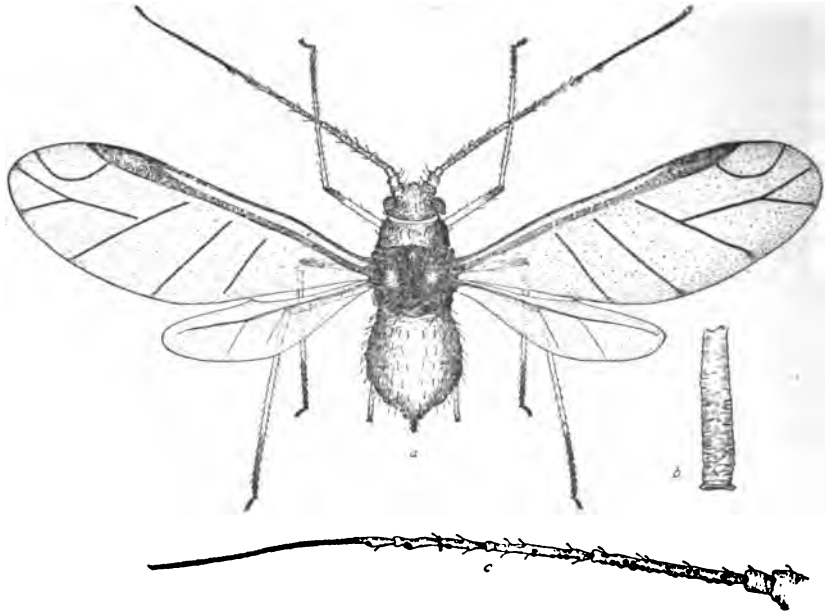


FIG. 26.—The Houghton gooseberry aphid: a, Winged form; b, cornicle of winged form; c, antenna of winged form. a, Much enlarged; b, c, more enlarged.

tips and ultimately produce a "witches broom" like that seen in the illustration (fig. 25).

SEASONAL HISTORY.

The eggs are laid on the bark under the loose folds which extend down the twigs. Occasionally also they occur on the bases of the buds or even on the thorns.

The eggs hatch with the expanding buds and the young stem-mothers place themselves on the underside of the leaves, the petioles, or tender twigs. The leaves soon curl and twist, forming a protection for the stem-mother and her young. The stem-mother and succeeding wingless forms therefore cause the twisting of the leaves.

The winged forms (fig. 26) occur in all generations from the second onward, even the stem-mother producing some winged forms.

¹ *Myzus houghtonensis* (Troop).

These winged ones leave the plants, and we have not been able to trace them farther. They begin to appear early in May.

The wingless forms carry on the infestation and in September and October the sexed forms appear. The male is very small and wingless and is slightly darker than the ordinary wingless form. The egg-laying female is somewhat larger than the male and also wingless. These mate and the female lays her eggs on the twigs a short time later.

THE ORNAMENTAL CURRANT APHIS.¹

The wingless forms of the ornamental currant aphid are pale greenish with the honey tubes dusky at the tips. The winged forms are similar in color with pale brownish lobes on the thorax. The egg-laying female is orange in color with pale yellowish spots, while the abdomen of the male is dark.

SEASONAL HISTORY.

This species usually occurs on the ornamental currants. The eggs hatch in the spring and numerous generations of wingless forms are produced. By August these are present in large numbers on the tender terminal twigs and to a less extent on the undersides of the leaves. Winged forms appear in September or earlier and ants are found attending the insects. Early in October the orange, wingless, egg-laying females may be found mating with the winged males and the eggs are laid shortly afterward.

THE WESTERN CURRANT APHIS.²

This species lives on the flowering currant in California, on which it makes curls or blisters similar to those produced by the currant aphid. The wingless form is green or yellowish green. The winged form is green with black head and thorax. The egg-laying female is whitish-yellow and the male red.

SEASONAL HISTORY.

The eggs are supposedly laid on the twigs and the stem-mother appears very early in the season. The winged forms begin to appear in March and the male and egg-laying female may be found as early as the month of May.

THE DOGBERRY APHIS.³

The dogberry aphid is very like the Houghton gooseberry aphid. It was found on the prickly gooseberry or dogberry and occurs also on the Buffalo currant (*Ribes aureum*). It differs from the Houghton gooseberry aphid in having fewer pores or sensoria upon the antennæ, and less distinctly knobbed hairs. Its life history is not fully known.

¹ *Macrostaphum ribellum* Davis.

² *Myzus ribifolii* Davidson.

³ *Myzus cynosbati* (Oest.).

GRAPE APHIDS ATTACKING THE FOLIAGE.¹

The well-known grape phylloxera¹ occurs in some localities upon grape foliage (fig. 27), but this species is not treated in this bulletin, since it is injurious principally to the roots and requires control



FIG. 27.—Galls of grape phylloxera on grape leaf.

measures radically different from those employed against foliage-inhabiting species.

THE GRAPEVINE APHIS.²

The grapevine aphis is very numerous in some localities, infesting the tender shoots and leaves (fig. 28) and sometimes the fruit clusters,

¹ *Phylloxera vitifoliae* (Fitch).

² *Aphis illinoensis* Shimer.

causing the berries to drop. It can be distinguished easily from any other forms occurring on the grape by its large size and its dark-brown color.

SEASONAL HISTORY.

The eggs of this species are laid upon the twigs of the black haw.¹ Very early in the spring they begin hatching, but these first stem-mothers may be killed by frost. Six or eight weeks later the aphids of the second generation mature, and these nearly all become winged. These migrants fly to the grape and produce young upon the tender growing shoots, where in less than 10 days they are mature and producing young. Reproduction on the grape continues throughout the summer, and often more than a dozen generations may occur. In each generation winged forms are found and these carry the infestation to new vines. During October fall migrants are produced, which return to the haw trees and deposit the egg-laying females. When mature these are fertilized by the winged males which follow the fall migrants, and egg laying results.

NATURAL ENEMIES OF APHIDS.

Aphids are attacked by various species of parasitic and predacious insects and by fungous diseases, and these agencies exert a very important influence in their control.

The combined effect of these several factors normally keeps the aphids pretty well reduced, but when for any reason their activities are lessened the aphids may increase enormously and do widespread injury. Heavy driving rains are believed to be inimical to aphids,



FIG. 28.—The grapevine aphid: Colony on grape shoot.

¹ *Viburnum prunifolium*.

whereas cool, cloudy weather seems to reduce the activities of the parasitic and predacious enemies, permitting the aphids to become correspondingly abundant.

Ladybird beetles (fig. 29) may be found in almost any colony of aphids, both the beetles and larvæ feeding freely on the insects.

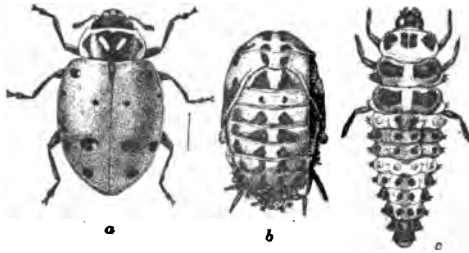


FIG. 29.—The convergent ladybird (*Hippodamia convergens*), an enemy of orchard aphids: a, Adult; b, pupa; c, larva. Enlarged. (Chittenden.)

Numerous species of these beetles attack the aphids, and they should be protected and encouraged when possible.

Larvæ, or maggots, of syrphus flies, also called sweat flies (figs. 30 and 31), are very generally present in aphid colonies and are most important checks to their increase.

The larvæ of two or three species of lacewing flies feed freely on aphids, although they are not so important as the insects mentioned above.

Probably the most important check to aphid increase, however, is the work of certain minute, four-winged flies which live parasitically on the aphids. These multiply very rapidly and under normal conditions are very effective. The bodies of parasitized aphids usually become enlarged, assume a more or less globular shape, and finally show the exit hole of the adult parasite. (Fig. 32.)

CONTROL MEASURES.

As previously stated, aphids feed upon plant juices which they obtain by means of a beak inserted into the plant tissues. Paris green, arsenate of lead, and other arsenicals, or stomach poisons, are therefore ineffective against these insects, and the so-called contact sprays, such as kerosene emulsion, soap washes, nicotine sprays, etc., must be employed. These sprays, to be effective, must come in contact with the bodies of the insects, and great thoroughness in spraying is necessary.

Two principal plans of attack may be followed in the control of orchard aphids. Those species which winter in the egg stage on the plants to be protected may be treated with sprays early in the spring as the buds are expanding, to destroy the young stem-mothers. Treatment at this time assumes that without it the aphids would become injurious later in the season and is in the nature of insurance.

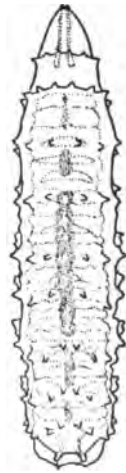


FIG. 30.—Larva of the syrphid fly *Allograpta obliqua*, an important enemy of aphids. Much enlarged. (Metcalf.)

Following the other plan, spraying is not done until the insects actually have become troublesome, which does not occur as a rule until after the foliage is well out. With species that cause the leaves to curl this is too late to obtain much benefit from spraying. In view of the more or less irregular occurrence of aphids many growers will prefer to delay treatment until the insects actually are present on

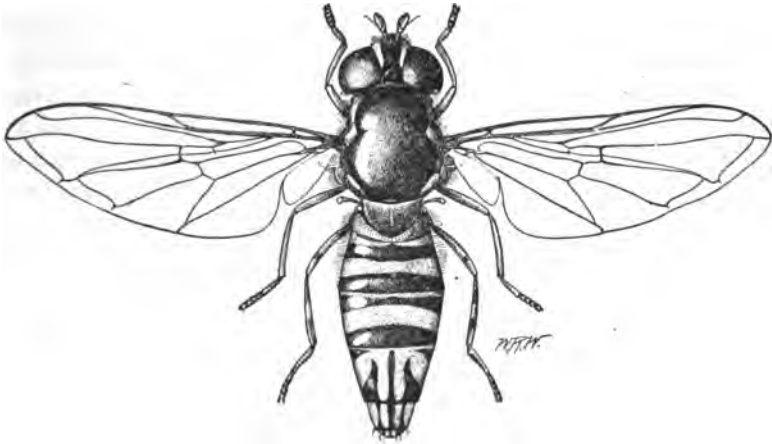


FIG. 31.—The adult syrphid fly *Allograpta obliqua*. Much enlarged. (Davis.)

the plants in destructive numbers, and in the case of those species which do not curl the leaves to any extent this plan will be satisfactory. Care should be taken, however, to treat the aphids promptly when they are found to be becoming abundant. It is a question for the grower to decide whether under his conditions danger of aphid injury, especially by the leaf-curling species, makes the bud application desirable or whether this danger is so small that he is warranted in taking chances on the insects becoming troublesome. Examination of the plants to determine the abundance of winter eggs and young stem-mothers on the opening buds should be of assistance in this connection, though abundant winter eggs are not always followed by aphid abundance, since many may succumb to unfavorable weather conditions.

INSECTICIDES.

INSECTICIDES MADE FROM TOBACCO.

COMMERCIAL NICOTINE SOLUTIONS.

Aphids are killed by surprisingly small quantities of nicotine in water, and because of the entire safety with which it may be applied to plants nicotine is better suited than other sprays to control these

insects. While the cost of the concentrated article is high, the extent to which it may be diluted makes the spray compare favorably in cost with other contact sprays. Nicotine is extracted from refuse tobacco, principally stems, by different commercial concerns, and is put on the market in several grades and strengths. The 40 per cent nicotine sulphate, containing 40 per cent of nicotine, is the solution principally used, although weaker grades of nicotine may be employed, provided care is taken that the spray be made so as to contain not less than 0.05 or 0.06 per cent of actual nicotine.



FIG. 32.—A colony of the black peach aphid on peach twig heavily infested by a species of parasitic four-winged fly. Enlarged.

Nicotine may be added either to the winter-strength lime-sulphur solution for the San Jose scale or to the dilute lime-sulphur solution and arsenate of lead spray employed in the control of insects and diseases of fruit and foliage. It may also be used in Bordeaux mixture and arsenate of lead spray without interfering with its effectiveness or in an arsenate of lead, milk of lime, and water spray. In orchard spraying the 40 per cent nicotine sulphate is used at the rate of about three-fourths of a pint to 100 gallons of water, lime-sulphur solution, or Bordeaux mixture. When used in water the addition of soap at the rate of 4 or 5 pounds to 100 gallons adds much to its spreading power and efficiency. *Soap should not be used with lime-sulphur solution, but may be used in Bordeaux mixture.* Where only a small quantity of spray is required the nicotine sulphate may be used at the rate of 1 teaspoonful to a gallon, or 1 ounce to 8 gallons of soapy water.

HOMEMADE NICOTINE SPRAYS.

Tobacco decoctions may be prepared readily at home, and, although varying somewhat in strength, will give as satisfactory results as the commercial products unless used too weak. The practicability of making the nicotine sprays will depend chiefly upon the availability and cost of the refuse tobacco. Tobacco stems, sweepings, and damaged tobacco are the most economical for this purpose and the dark types of tobacco, owing to their relatively high nicotine content, are preferable to light-colored tobacco. If a desirable type of refuse tobacco can be purchased at a reasonable price, the fruit grower can often make nicotine sprays profitably at home. The first cost of the tobacco waste is reduced, since, after the nicotine has been extracted, the tobacco still has a fertilizer value of about one-half its first cost.

The amount of refuse tobacco necessary to give a spray containing 0.05 or 0.06 per cent of nicotine will vary considerably, as will be noted in the following table adapted from a publication of the Virginia Agricultural Experiment Station,¹ which is given as a guide:

Formula for making nicotine extracts.

Kind of tobacco.	From—	Nicotine.	Number of pounds per 100 gallons necessary to make solutions containing different percentages of nicotine.	
			0.06 per cent.	0.05 per cent.
Light stems.....	Richmond, Va.....	Per cent. 0.481	145	121
Do.....	Danville, Va.....	0.609	110	91
Sweepings.....	do.....	0.884	74	62
N. L. Orinoco.....	Appomattox, Va.....	5.535	12½	10½
Olive.....	Pohatan, Va.....	3.367	19½	16½
Light.....	Danville, Va.....	2.984	22	18
Sweepings.....	Louisville, Ky.....	7.753	91	85
Smoker.....	Chatham, Va.....	2.306	28½	23½
Wrapper.....	do.....	3.05	21½	18
Cutter.....	do.....	3.466	19	15
Dark.....	Appomattox, Va.....	2.835	23½	19½
N. L. Orinoco.....	Bowling Green, Va.....	5.629	11½	10
Medium smoker.....	Chatham, Va.....	3.766	17½	14½
Common smoker.....	do.....	2.47	26	21½

Since it is impracticable for the fruit grower to have the refuse tobacco chemically analyzed, he should approximate the class to which it belongs and use according to the foregoing table. The chief danger lies in making the solution too weak. If made stronger than necessary, no damage to the plant will result.

METHODS OF MAKING.

One of the most convenient as well as satisfactory methods of making nicotine sprays on the farm is by simply soaking the tobacco

¹ Ellett, W. B., and Grissom, J. Thomas. Preparation of nicotine extracts on the farm. Va. Agr. Exp. Sta. Bul. 208. 1914.

in the full quantity of water, with occasional stirrings, for a period of 24 hours. About 70 to 80 per cent of the nicotine will be extracted. After straining the tobacco solution to remove the particles of leaves and stems, it is ready for use.

The tobacco spray may also be made in a lime-sulphur plant equipped with steam. Place the proper amount of tobacco and water in the cooker and release the steam, and, as soon as the water reaches the boiling point, shut off the steam. As soon as the solution has cooled it is ready to use. By this method about the same percentage of nicotine is extracted as by the soaking process. The solution should never be boiled, as the nicotine is volatile.

Nicotine sprays should not be made up until they are to be used, since fermentation begins within two or three days, perhaps spoiling them for spraying purposes.

The homemade nicotine solutions, when prepared as above at the strengths indicated, will give control of most aphids. But as a matter of precaution it will be advisable to observe the effect of the spray upon the insects, and, if not effective, to strengthen it.

TOBACCO DUST.

Tobacco dust has long been recommended for the control of the woolly apple aphid on the roots of the apple, and for other root-inhabiting insects, and to a less extent for dusting low-growing plants, as currants and gooseberries for the destruction of aphids.

Tobacco dust has some value as a treatment for the woolly aphid on the roots of the apple, its effectiveness varying much with the amount of nicotine in the dust and its fineness and the character of the weather. Abundant moisture in the soil, as from irrigation or rains, leaches out the nicotine, thus destroying the insects to a greater or less extent. Where tobacco dust may be obtained cheaply its use is warranted for the woolly aphid, but the purchaser should insure himself that the dust is not the grade sold for fertilizer purposes from which the nicotine has been extracted. In addition to its insecticidal value, tobacco dust has a distinct fertilizer value.

SOAP SPRAYS.

Sprays made from several kinds of soap are much used for the destruction of various soft-bodied sucking insects, particularly aphids, the pear psylla, certain plant-bugs, etc.

COMMERCIAL FISH-OIL SOAPS.

The commercial fish-oil soap, formerly known under the trade name of "whale-oil soap," is usually made from fish oils combined with either caustic soda or potash and should contain not over 30 per cent of water. An average grade of a soda fish-oil soap should

contain, in addition to the water, about 10 per cent of caustic soda, 58 per cent of fatty matter as anhydrides, and about 2 per cent of other matter. Soda fish-oil soap is generally of medium to hard consistency, whereas the potash soaps are much softer. They are brownish in color, with a distinct fishy odor.

For foliage sprays the fish-oil soap is dissolved at the rate of 1 pound in 3 to 4 gallons of water or at greater dilutions, depending upon the insects to be treated and the hardness of the foliage. Soda soaps are fairly hard and usually require slicing and dissolving in hot water.

Fish-oil soaps may be used with the following spray materials to increase their spreading and adhesive qualities: Arsenate of lead, nicotine solutions, Bordeaux mixture, and sulphur. *Do not use soap in lime-sulphur solutions, or in waters containing compounds of lime and magnesium (hard waters).*

HOMEMADE FISH-OIL SOAP.

A good fish-oil soap¹ may be made at ordinary summer temperatures without the aid of external heat according to the formula given below:

Caustic soda.....	pounds..	6
Water.....	gallon..	$\frac{1}{2}$
Fish oil.....	gallons..	3 $\frac{1}{4}$

Thoroughly dissolve the caustic soda in the required amount of water. Then, while stirring constantly, add the fish oil very slowly and continue active stirring for about 20 minutes or until the soap is complete. The homemade fish-oil soaps may be used in about the same proportions as the commercial products.

LIQUID FISH-OIL SOAP.

Commercial liquid fish-oil soap may be substituted for the harder fish-oil soaps. Apply according to the directions given for fish-oil soap, using 1 pint of the liquid soap in place of 1 pound of the hard soap. Liquid soaps are especially convenient in making oil emulsions.

TOBACCO FISH-OIL SOAP.

Commercial fish-oil soaps containing a small percentage of nicotine are sold for insecticidal purposes. Soaps of this kind are somewhat expensive and their use is scarcely justified unless the nicotine is present in sufficient quantity to have distinct insecticidal value, namely, 0.05 to 0.06 per cent in the completed spray.

¹ Van Slyke, L. L., and Urner, F. A. N. Y. Agr. Exp. Sta. (Geneva) Bul. 257. 1904.

QUASSIA AND FISH-OIL SOAP.

Quassia extracts are used for destroying certain sucking insects, especially the plum or hop aphid. Solutions containing quassia are more effective when combined with soap, which serves as a spreader and "sticker." Various formulas with different amounts of quassia chips and soap have been used, depending upon the insects to be destroyed. The following formula gives a fairly strong spray solution:

Quassia chips.....	pounds..	2½, or pound..	¼
Fish-oil soap.....	do....	5, or do....	¼
Water.....	gallons..	50, or gallons..	5

First dissolve the soap in a little hot water and pour into the container and then add sufficient water to make the total product equal to that given in the formula. Place the quassia chips (small chips are best) in cloth sacks and submerge in the soapy liquid for 24 hours. The soap aids in extracting the quassia. Instead of soaking the chips as above, they may be boiled in the same amount of soapy water for 4 to 5 hours. In order to extract a large percentage of the quassia the full amount of the water indicated in the formulas should be used. Fruit growers will find no particular advantage in using quassia chips over nicotine solutions or kerosene emulsion. Quassia chips are not readily obtainable and the homemade extract, owing to its somewhat variable strength, is not always dependable.

KEROSENE EMULSION.

Kerosene emulsion has long served as a standard spray for control of soft-bodied sucking insects. If well made and properly diluted kerosene emulsion will give satisfactory results. *It should never be combined with lime-sulphur.*

A good stock solution of kerosene emulsion containing 66 per cent of oil (by volume) may be made according to the following formula:

Kerosene (coal oil, lamp oil).....	gallons..	2
Fish-oil or laundry soap (or 1 quart soft soap).....	pound..	¼
Water.....	gallon..	1

First dissolve the soap in boiling water; then remove the vessel from the fire. Immediately add the kerosene, and thoroughly agitate the mixture until a creamy solution results. The stock solution may be more conveniently made by pouring the mixture into the tank of a spray pump and pumping the liquid through the nozzle back into the tank for some minutes. The stock solution, if properly made, should last for some time, but it is better to make it up as needed. Do not dilute until ready to use. To make a 10 per cent spray (the strength for trees in foliage) add, for each gallon of the stock solution, about 5½ gallons of water. Agitate the mixture in all cases after adding the water.

The preparation of the emulsion may be simplified by the use of a naphtha soap. No heat will be required, as the kerosene will combine readily with the naphtha soap in water, when thoroughly agitated. If naphtha soap is used, twice as much will be required as is given for the other kinds of soap in the foregoing formula, and soft or rain water should be used in making the emulsion. In regions where the water is "hard" this should first be "broken" with a little carbonate of soda, or common lye, before use for dilution, to prevent the soap from combining with the lime or magnesia present, thus liberating some of the kerosene; or rain water may be employed.

SPRAYING FOR APPLE APHIDS.

Experiments made by the Bureau of Entomology and several of the agricultural experiment stations, notably those of Colorado and Oregon and the Geneva, N. Y., station, show that the aphids attacking the fruit and foliage of the apple are best controlled by spraying in the early spring just as the buds are breaking to destroy the stem-mothers. At this time the insects are hatching from the winter eggs, and are so exposed that one thorough treatment should destroy from 95 to 98 per cent of them and prevent their increase to such an extent that they will not cause serious injury later in the season. This applies especially to the oat aphid, the rosy aphid, and the clover aphid.

THE DELAYED DORMANT TREATMENT.

The plan is to delay the application of the winter-strength lime-sulphur solution until the buds begin to show green, and, by the addition to the spray of tobacco extract or nicotine, effect a combination treatment for the San Jose scale¹ and the aphids. Principally nicotine sulphate, containing 40 per cent nicotine, is used at the rate of $\frac{3}{4}$ pint to 100 gallons of lime-sulphur spray. The nicotine destroys the hatched aphids that are hit with the spray, while the lime-sulphur, in addition to controlling the scale, is thought to destroy a large proportion of the eggs of the aphids on the trees, should any be still unhatched.

In orchards badly infested with the scale it is doubtful whether the grower should take chances with the delayed dormant treatment, especially in large orchards where the spraying takes considerable time. Unfavorable weather or other conditions may so delay spraying operations that the foliage will develop to such an extent that the use of dormant-strength lime-sulphur would endanger the leaves. Such late spraying, furthermore, would not be as effective as desirable in destroying the aphids, since most of these would be more or less protected by the foliage or would have penetrated the expanding shoots.

¹ *Aspidiotus perniciosus* (Comst.)

Figure 33 illustrates an apple bud with aphids clustered on it in about the right condition for the delayed dormant treatment. Figure 34 shows an apple bud with leaves so far out that the aphids are pretty well protected between the leaves, and the delayed dormant application would not be very effective in killing the aphids, and might cause some foliage injury.

In the case of the green apple aphid, which lives on the apple throughout the year, the suppression of stem-mothers in the spring

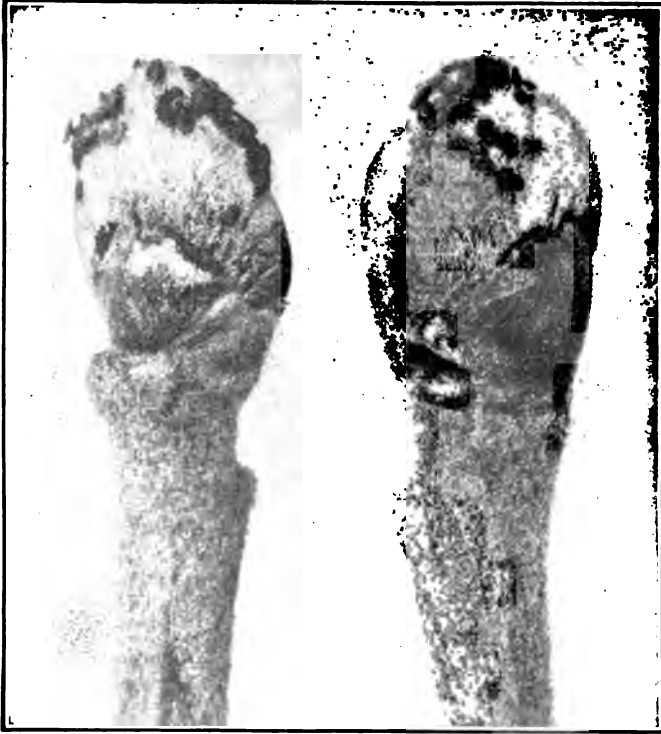


FIG. 33.—Young stem-mothers of an apple aphid and condition of buds when the bud spraying should be given. Enlarged.

does not always guarantee freedom from this insect during midsummer, and supplementary treatments sometimes are desirable. In the case of young orchards, where the green apple aphid is principally to be considered, the bud spray should be given, but additional applications should be made in summer if found necessary.

Spraying in the fall for the destruction of the fall migrants and the egg-laying females has been tried to a limited extent, but the adequacy of the treatment has not yet been proven.

Annual bud spraying of apple orchards would appear to be good practice, and over a series of years would no doubt prove profitable,

This is especially true of varieties subject to "fruit spots" or "stigmonose," since these troubles have been shown by the Bureaus of Plant Industry and Entomology to be due, in part at least, to the activities of aphids.

CONTROL OF APHIDS ON PLUM, PEACH, CHERRY, ETC.

The several aphids which occur on plum, as well as the green peach aphid, pass the winter on the trees in the egg stage, hatching in the spring about the time when foliage appears. None of these species curls the foliage to the same extent as do some of the apple



FIG. 34.—Young apple shoot too far expanded for successful aphid spraying. Enlarged.

aphids, and thorough spraying of the trees when the insects are in evidence usually will be satisfactory. Nevertheless spring spraying against the stem-mothers is desirable in orchards where the insects have been troublesome regularly or where winter eggs are seen to be present in numbers.

The black peach aphid, which winters on the roots of the peach, should be treated as soon as the insects are observed to be present on the foliage and twigs, and in regions where they are likely to be troublesome, as on nursery stock in sandy situations, careful watch should be made for their first appearance.

The black cherry aphid is likely to be in evidence each year on cherries. The insect winters on the trees in the egg stage and the eggs hatch somewhat in advance of the opening of the buds. Since this species causes a decided curling of foliage so that later treatments

are not satisfactory, the effort should be made to destroy the stem-mothers as the buds are breaking.

CONTROL OF APHIDS ON CURRANT, GOOSEBERRY, AND GRAPE.

All of the important aphids attacking the currant and gooseberry pass the winter on these plants in the egg stage, the stem-mothers hatching as the leaf buds are opening and soon causing the leaves to become more or less pitted or curled. It is especially important, therefore, to spray as the shoots are pushing out, to destroy the stem-mothers before they are protected by the distorted foliage. In spraying for these insects later in the season the liquid should be directed upward to wet the insects on the underside of the leaves.

The grapevine aphid, while often abundant on the terminal growth, is rarely very injurious. It is much subject to parasitic and predatory enemies, and migrates from the grape to *Viburnum* in early fall. When so abundant as to require treatment, any of the contact insecticides may be used.

CLEAN CULTURE.

As the reader will have learned, most aphids have a winter and early spring host plant, and from this they migrate to other plants, on which they subsist for several weeks or months during the summer.

In most instances this alternation of food plants is essential to the life of the species, and in general the aphids are most troublesome in regions where alternate hosts are present in abundance. Often one or more of the host plants are of little or no economic importance in the locality, and in some cases are troublesome weeds. The destruction of worthless plants is desirable and should serve materially to reduce the aphids in question. Thus, in the case of the rosy aphid, the alternate food plants of which are species of plantain, the destruction of these in and about orchards is especially desirable, and should be a part of the remedial work against this pest in localities where it is more or less chronically injurious.



Farmers' Bulletin 1129

United States Department of Agriculture

DISEASES of SOUTHERN PECANS



THIS BULLETIN is intended to aid nurserymen, growers, and prospective growers in obtaining a more thorough and definite knowledge of the various diseases of the pecan, the extent of their distribution, and their relative importance.

Observed facts are stated as facts and opinions as opinions, and every effort has been made to avoid confusing facts with opinions.

Typical illustrations are presented wherever these will contribute to the text and be an aid in recognizing the diseases discussed.

Where remedies are known they are given, and where they are not known such information as is available is presented.

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Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief
Washington, D. C. September, 1920

DISEASES OF SOUTHERN PECANS.

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IT IS THE PURPOSE of this bulletin to give in a concise, clear, and nontechnical manner such information on pecan diseases as is at present available. The matter here presented is based not only on the observations and experiments of the writers, but upon all reliable sources of information. It is intended to apply to commercial orchards of the southern and southeastern coastal plain of the United States, but not to the so-called northern pecans, originating in the latitude of southern Indiana or farther north, which are adapted to producing their crop in a growing season of 200 days or less and are subject to climatic conditions very different from those of the southern pecans.

Rosette and scab are the most serious diseases of the pecan, but other troubles are also the cause of a loss of trees and nuts. An understanding of the nature of these troubles will be of substantial benefit to growers and nurserymen.

DISEASES DUE TO SPECIFIC ORGANISMS.

SCAB.¹

Scab is a fungous disease of the leaves, twigs, and nuts. Figure 1 shows a typical case of leaf infection. The small, velvety, black spots on leaves are seldom sufficiently numerous to do serious damage. The appearance of the diseased spots on the twigs is quite similar to that on the leaves, but the damage done by twig infec-

¹ Caused by *Fusicladium effusum* Wint.

tion may be much more serious. In cases of severe infection the tips of the twigs are killed. The greatest damage is caused by the fungus attacking the nuts. Figure 2 shows a typical case of nut infection. When this infection occurs early in the season the diseased nuts drop before maturity, and late summer infection results in undersized, faulty nuts.

The southern pecan belt is fairly well confined to that portion of the South in which cotton is grown. Although scab is found throughout this territory, serious damage is confined to a limited number of varieties of pecans grown in the warmer and more humid sections.

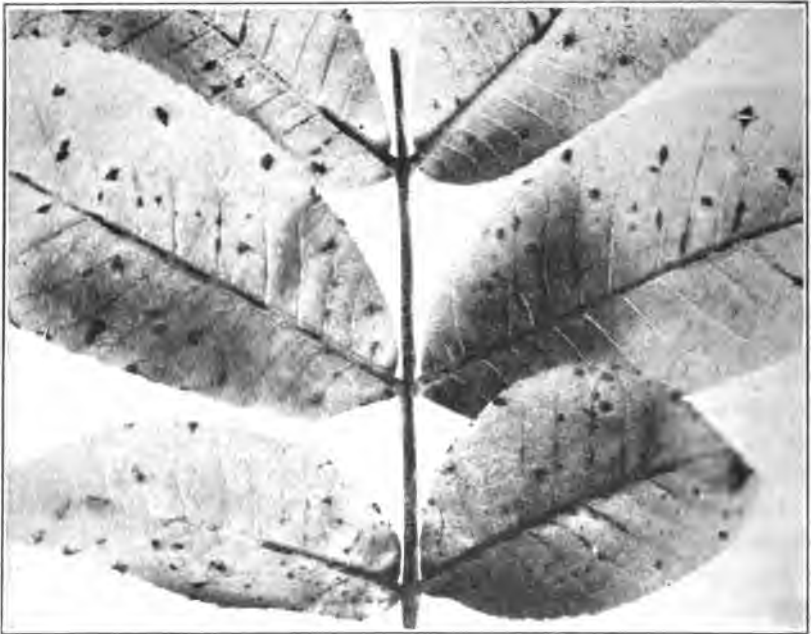


FIG. 1.—A portion of a pecan leaf typically marked by the scab fungus. The spots are raised, velvety, and black in color.

The disease becomes less serious as one proceeds inland from the Gulf and Atlantic coasts; 150 miles inland it is of relatively minor importance. Certain varieties which can not be grown successfully near the coast are but slightly attacked at this distance inland, and other varieties only slightly susceptible to infection near the coast are here entirely free from the disease. ▲

There is great variation in the susceptibility of varieties. Certain sorts are entirely immune, while others so readily succumb to the disease that they can not be grown commercially. All gradations exist between these two extremes. Among the most susceptible varieties are the San Saba, Georgia, and Delmas. The Van Deman, Schley, Pabst, and Bolton pecans follow these in degree of susceptibility and

are sometimes seriously affected. The Mobile, Alley, Moore, and Nelson varieties are usually free from the disease, but suffer some loss occasionally, while the Stuart, Frotscher, Money-maker, Teche, Russell, and Success are so highly resistant as to be practically immune. Infection is most serious during seasons of frequent rains and heavy dews, when the crop of the most susceptible varieties is usually completely destroyed.

The control of scab can best be effected by the propagation of immune or highly resistant varieties. Established orchards of susceptible sorts may be and are successfully top-worked to scab-resistant varieties. The use of resistant varieties only is strongly recommended in all orchards within 150 miles of the Gulf and Atlantic coasts. In orchards which the owners do not wish to top-work scab can be successfully controlled by spraying.

A standard Bordeaux mixture composed of 4 pounds of bluestone (copper sulphate), 4 pounds of quicklime, and 50 gallons of water has been found to be the most satisfactory fungicide for preventing scab. The

addition of 1 pound of resin-fishoil soap to each 50 gallons of the preparation is recommended, as it materially increases the spreading and sticking qualities of the mixture.

Spraying to control scab is essentially a preventive measure. If the nuts are kept covered with the fungicide from the time they are formed, about the first of May, until the first of September, when growth is almost complete, scab infection will be prevented. Although this is difficult it can be done sufficiently well to save a large part of the crop on so highly susceptible a variety as the Delmas in a season of severe infection. Definite rules can not be given for the number of applications to be made. This will depend



FIG. 2.—Pecans infected by the fungus causing the scab. Nuts on which the disease has developed to the extent here shown almost invariably fall from the tree before reaching maturity.

entirely on the frequency and the amount of rain. The only rule that can be followed is to keep the nuts covered with the fungicide from the time they are formed until September 1. This usually requires three to five sprayings, and it can not be too strongly emphasized that merely shooting the spray into the tree is not sufficient. The work must be done carefully and the nut clusters covered. Careful work in this connection is not incompatible with rapid work, but for the spraying to be done thoroughly as well as rapidly it is necessary that the workmen understand the purpose of the spraying to be done and then use care in attaining that purpose.



FIG. 3.—A high-power spray machine at work in a pecan orchard. These trees were about 40 feet high, but no difficulty was experienced in doing a thorough job of spraying with this type of outfit.

The size of the orchard and the height of the trees must determine the size and capacity of the spray machine to be used. The low-power machines designed to spray peach and apple orchards have proved decidedly unsatisfactory in any but young pecan orchards. Pecan trees grow to great height. Trees 50 to 60 feet high are not uncommon, and trees 35 to 40 feet high are frequently found in bearing orchards of the South. The ordinary 3 to 4 horsepower spray machine with extension rods and tower can not be expected to do satisfactory work beyond 30 feet from the ground. Figure 3 shows a type of machine well adapted for spraying tall pecan trees. It is equipped with a 10-horsepower engine and a pump of sufficient capacity to discharge 20 gallons of liquid per minute

through two lines of hose. Spray guns are used instead of extension rods, and the operators work from the ground and from the top of the tank. The pressure developed, 250 to 350 pounds as shown on the gauge, is sufficiently powerful to carry a large volume of liquid in the form of a fine spray to the tops of 50-foot trees. Liquid thrown with such force enables the operator to spray the center of the trees as well as the outside.

High-pressure sprayers require specially constructed hose and hose connections. It is a great annoyance to try to operate a high-pressure outfit with the ordinary type of hose and connection. Such a machine throws out the material freely, and the problem of refilling is of considerable importance. Unless convenient refilling facilities are arranged, more time is usually consumed in driving to the water supply and loading than in spraying. This problem can best be solved by having one or more teams haul the water and spray materials to the sprayer. Provision can be made to fill the supply wagons by a gravity system. The high-power machines are usually equipped with a tank filler operated by the spray motor, which will fill the spray tank at the rate of 30 to 40 gallons a minute.

NURSERY BLIGHT.*

Nursery blight is principally a disease of nursery stock, but it is occasionally found on mature trees. The disease is favored by any factor reducing the vitality of the trees. The strong competition between the trees in the nursery seems to be especially favorable for its development. Mature trees planted too closely or those neglected in care and cultivation are sometimes damaged slightly. This disease is also frequently found on rosetted trees.

Nursery blight is found only on the leaves. The first infections usually appear in April as very small reddish spots with a white speck in the center. Single spots are seldom more than one-eighth of an inch in diameter. Frequently two or more spots unite, forming a larger spot. The older infections appear almost white, surrounded with a dark-brown border. The spots appear dark brown on the under surface of the leaves.

While the infections may occur at any point on the leaf surface they are most commonly found along the midrib and larger veins. Often they grow together along the midrib, forming an elongated spot the length of the leaflet. The leaflet shown in figure 4 is typical of this trouble.

Nursery blight is controlled successfully by spraying with Bordeaux mixture. The first application should be made after the leaves develop and before infection begins. In southern Georgia

* Caused by *Phyllosticta caryae* Peck.

this is usually about the middle of April. The number and frequency of applications must be determined by the amount of rainfall.



FIG. 4.—A leaflet seriously affected by nursery blight.



FIG. 5.—A badly pruned and neglected top-worked pecan tree. This tree is a total loss.

To prevent the disease it is necessary that the leaves be kept well covered with the fungicide, and three to five sprayings will usually accomplish this result.

WOOD-ROTTING FUNGI.

Wounds made in pruning pecan trees and those arising from other mechanical injuries, such as careless cultivation, hail, winter injury, and windstorms, are all possible points of entrance for wood-rotting fungi. The hot, humid climate of the Southeastern States favors the rapid development of the fungi, and unless wounds are given



FIG. 6.—The characteristic appearance of a pecan leaf affected with the brown leaf-spot.

protection from infection and so handled as to facilitate healing, it is almost inevitable that fungi will gain entrance and endanger the entire tree.

While pruning in some pecan orchards has been properly done, this is not universally the case. The orchards which have been handled badly in this respect are probably in the minority, but it is a fact that wood-rotting fungi, entering through wounds, are weakening trees in many orchards. Trees affected in this way will fre-

quently stand for many years, but the reduction of their life and crop-producing power is inevitable. That losses of this nature have not already been felt is explained by the newness of the industry.

Figure 5 shows a tree which was a total loss on account of the ravages of wood-rotting fungi entering through wounds improperly made and left unprotected. The matter of protecting pecan trees from wood-rotting fungi has been fully discussed by the senior writer in another bulletin.³

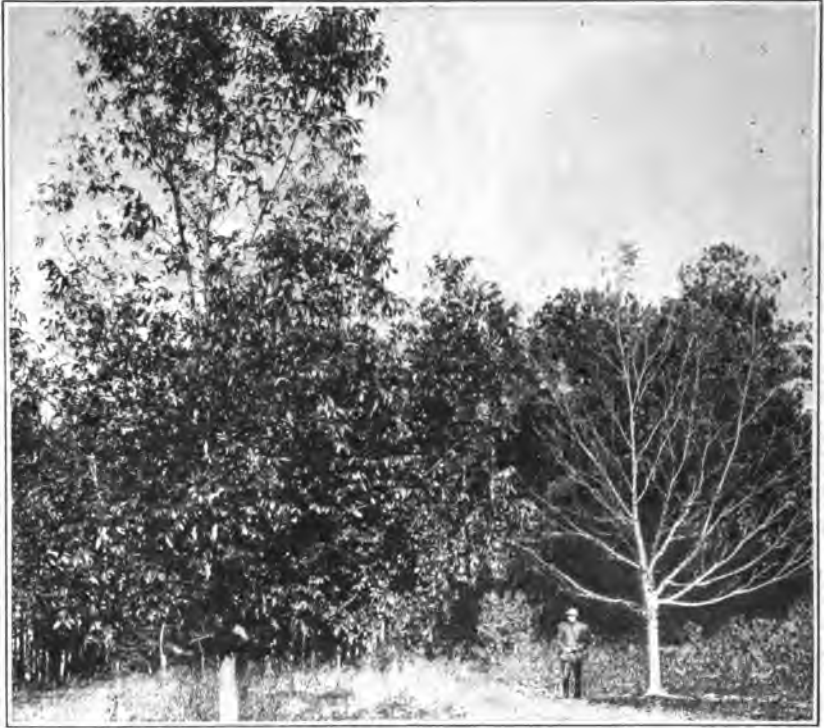


FIG. 7.—The unsprayed tree in the right background was defoliated by brown leaf-spot, while the tree in the left foreground which had been sprayed with Bordeaux mixture was free from disease.

BROWN LEAF-SPOT.⁴

A pecan leaf characteristically marked by the brown leaf-spot is shown in figure 6. These spots, ranging from one-eighth to one-half of an inch in diameter, are usually reddish brown in color, though the old spots not infrequently become grayish and develop concentric rings. This is the most common leaf disease of the pecan and is distributed throughout the pecan belt.

³ McMurrin, S. M. Preventing wood-rot in pecan trees. U. S. Dept. Agr., Farmers' Bul. 995, 8 p., 10 fig. 1918.

⁴ Caused by *Cercospora fusca* Rand.

These spots usually appear about the middle of July, though they are occasionally found earlier in the season on mature leaves, but not on young, tender growth. They rapidly increase in number and size toward the end of the growing season and occasionally cause some premature loss of foliage. Leaves of trees weakened from any cause are particularly susceptible to infection by the fungus causing brown leaf-spot, and such trees frequently shed their foliage a month before their healthy neighbors as a result of a severe attack of this disease.

The disease can be controlled by spraying with Bordeaux mixture, and figure 7 shows in the left foreground a sprayed tree in practically full foliage, while its unsprayed neighbor is completely defoliated. Beginning on July 1, the tree in foliage received three sprayings at 3-week intervals.

Since this disease appears only during the latter half of the growing season and does no serious damage to vigorously growing well cared for trees growers need not concern themselves with its control other than to keep their trees in a thrifty condition.

CROWN-GALL.*

Crown-gall is a distinctly minor disease of the pecan, on account of its rare occurrence. It is here brought to the attention of growers, as it had been occasionally observed. As the name implies, this disease manifests itself as an enlargement on the roots or collar of the tree. Figure 8 shows a typical case of the crown-gall. Nursery trees should be inspected before planting, and those showing galls should be discarded, as trees infected with this disease may develop more slowly in the orchard.

ANTHRACNOSE.*

The anthracnose of the pecan has been found by the writers only on the mature or very nearly mature husks of the nuts, as shown in



FIG. 8.—Typical specimen of crown-gall on a young pecan tree.

* Caused by *Bacterium tumefaciens* Sm. and Town.

* Caused by *Glomerella cingulata* (Stonem.) S. and V. S.

figure 9. These black, irregular, sunken spots can scarcely be called a diseased condition, as growth is practically complete when they appear. So far, the anthracnose has done no damage and for the present may be disregarded by growers.

POWDERY MILDEW.⁷

Powdery mildew is a surface growth found on the leaves and nuts. It appears during May and June, especially during seasons of considerable rainfall and high humidity.

Owing to its habit of coating the leaves and nuts with a white powdery growth, it frequently causes growers some concern. The writers have observed this disease as appearing rather commonly throughout the pecan belt, but have no record of its doing any



FIG. 9.—Spots on the husks of mature pecan nuts caused by the anthracnose fungus.

noticeable damage to either the leaves or the nuts. During dry weather the fungus disappears. Infected nuts develop normally and show no evidence of injury.

MISTLETOE.⁸

Mistletoe is rarely seen in well cared for orchards, but it is common on individual trees, particularly old trees which receive no care. Figure 10 shows an old seedling tree heavily infected with mistletoe. This plant is an active parasite. It penetrates the tissues of the tree and draws its nourishment from it. When any value is attached to a tree the mistletoe should be removed, care being taken either to kill the root by applying carbolineum or to cut it out.

DIEBACK.⁹

A disease of pecan limbs and twigs termed dieback was first reported by Fawcett¹⁰ and later by Stevens¹¹ and by Matz.¹²

⁷ Caused by *Microspheera alni* Wallr. Wint.

⁸ For a full discussion of the mistletoe and its various host plants, see Bray, W. L., The mistletoe pest in the Southwest. U. S. Dept. Agr., Bur. Plant Indus. Bul. 166, 39 p., 7 fig., 2 pl. 1910.

⁹ Caused by *Botryosphaeria berengeriana* De Not.

¹⁰ Fawcett, H. S. Dieback. In Fla. Agr. Exp. Sta. Rpt. [1908]/1909, p. lxi. 1909.

¹¹ Stevens, H. E. Pecan diseases. In Fla. Agr. Exp. Sta. Rept. [1914]/1915, p. xci. 1915.

¹² Matz, J. Pecan dieback. In Fla. Agr. Exp. Sta. Rpt. [1915]/1916, p. 99R-107R. 1916.

———. Pecan dieback. In Fla. Agr. Exp. Sta. Rpt. [1916]/1917, p. 87R-89R. 1917.

It appears from Matz's investigations that the fungus responsible for the disease is but weakly parasitic; that it causes little or no injury to vigorously growing healthy trees, but that it will produce cankers and even kill twigs and limbs of trees lacking in vigor, as, for example, those suffering from rosette or from winter injury.

This disease appears to be of distinctly minor importance at present, and there is little likelihood of its causing any material damage to well cared for, vigorous orchards. When it occurs, diseased limbs should be pruned out and destroyed.

DISEASES DUE TO ENVIRONMENTAL FACTORS.

ROSETTE."

Rosette is a disease of the tree and has so far proved to be the most serious with which the pecan industry has to contend. In its earliest stages rosette is indicated by a few small, wrinkled, yellow-mottled leaves at the end of the branches. All gradations of the disease are found between that shown by these first symptoms and the condition illustrated in figure 11, where the trees are dying. The writers have never seen a tree which has died as a direct result of rosette, but affected trees become so weakened that frequently they are killed by winter injury and by borers. Seriously affected trees rarely bear nuts, and they make but little growth.

The conditions under which this disease occurs give the key to its cause and prevention. By far the most of it is found on soils which are obviously lacking in plant-food material, in humus, and in moisture-holding capacity; for instance, eroded hillsides or fields which have been cropped to the point of exhaustion, as evidenced



FIG. 10.—An old and neglected pecan tree carrying a large amount of mistletoe.

¹¹ For a full discussion of pecan rosette and experiments for its control, see McMurren, S. M., Pecan rosette in relation to soil deficiencies. U. S. Dept. Agr. Bul. 756, 11 p., 4 fig. 1919.

by the poor, yellow growth of weeds which they produce. Cases are also found on soils which on superficial examination are apparently well suited to the production of healthy trees, but the subsoil invariably shows some form of hardpan, heavy impervious beds of clay, or soft white sand. In other words, the rosette is found on soils which are for some reason ill suited to conserve moisture or to give up moisture and its content of plant-food material when needed.

The native habitat of the pecan is the banks and second bottoms of the Mississippi and its tributaries and other streams of the Southwest. The soils in these places are of uniform formation to a



FIG. 11.—Typical specimens of badly rosetted pecan trees.

great depth and are frequently supplied by overflow with enriching material. The pecan has been growing in such soils through an unknown number of centuries, and trouble is sure to follow if orchards are set on poor or badly formed soils.

The rosette may be overcome on soils readily susceptible to improvement by consistently following some soil-building policy, such as the annual use of stable manure and leguminous cover crops, but it appears that in most instances cases of the disease caused by bad subsoil conditions had best be abandoned. An exception to this statement should be noted where the trouble is caused by the so-called piney-woods hardpan. This formation can be readily broken by small charges of explosives, and growers report a quick recovery of diseased trees when this is done.

WINTER INJURY.

A typical case of winter injury is shown in figure 12. The affected tree put out its leaves in the spring, grew for several weeks on the food stored in its trunk and limbs, and then withered. An examina-



FIG. 12.—A young pecan tree killed at the collar by extreme cold. The top had leaved out and then quickly wilted and died. This is the typical condition of winter-injured trees in the spring. Later in the season they usually send up shoots from the uninjured roots.



FIG. 13.—A typical case of winter injury. The tissue between the white band and the surface of the ground was completely killed, and new sprouts came up from the uninjured roots. This is the usual condition about midsummer.

tion made at that time (May 5) showed the trunk to be completely dead for a foot above the ground. Above that the trunk and limbs showed no evidence of injury. Quite frequently trees injured in this manner send up shoots from below the ground line, as shown in figure 13. In this case, also, the trunk of the tree for about a foot above the ground had been

completely killed by extreme temperature changes; the top had grown for a few weeks, then withered and died; and the roots had thrown up shoots.

This trouble is caused by sudden and excessive changes in temperature during the late fall and winter. 'Young trees which are



FIG. 14. — Young pecan tree showing the method of wrapping to prevent winter injury. It has proved very effective in eliminating the trouble.



FIG. 15.—A mature neglected seedling pecan tree showing the condition known as staghead. The ends of the branches in the top of the tree are mostly dead.

making a vigorous late growth are most susceptible. If the damage is discovered early in the spring, the injured portion will be found to have a soft, darkened, watery appearance and usually a sour odor. As a result this type of injury is known as sour-sap, or sun scald. Within a few weeks after the tissues are damaged shot-hole borers usually riddle the bark with many small holes. This, however, is a secondary trouble. This group of insects rarely injures healthy pecan trees, but, on the other hand, almost invariably attacks dead or dying trees.

Winter injury causes a loss of many young trees annually, and must be considered a rather serious problem to the owner of a young orchard. So far as the writers are informed it has never been reported on trees over 9 years of age. In younger orchards, however, it is necessary to guard against this source of loss. By avoiding cultivation and fertilization after midsummer and by sowing cover crops in June or July, the growth of the trees will be checked and their susceptibility to cold reduced. In certain orchards with which the writers are familiar the above practices did not prove sufficiently effective to eliminate losses, so the owners resorted to wrapping the bodies of the trees each fall with old fertilizer sacks, as shown in figure 14, which were removed in the spring. This practice prevented further trouble.¹⁴

STAGHEAD.¹⁵

A typical case of this disease is shown in figure 15. It is a rather uncommon trouble and can not be considered serious. In the writers' observations it has occurred only on mature trees, usually old trees, which have been totally neglected so far as cultivation and fertilization are concerned. The foliage of trees so affected is green and healthy in appearance. Most of the dying of the branches is confined to the tops of the trees. Repeated examinations of the dead wood for evidence of parasitic organisms have given negative results.

Because of the merely occasional occurrence of this disease on isolated trees or small groups of trees, no experiments have been conducted to remedy it, but suitable cultivation, fertilization, and pruning to remove the dead wood will probably so stimulate the vigor of affected trees as to free them from the trouble.

TIPBURN.

A typical case of tipburn is shown in figure 16. This trouble invariably starts by a browning of the tip, the margin, or sometimes



FIG. 16.—Pecan leaflets showing two stages of tipburn, a condition caused by excessive evaporation.

¹⁴ For a discussion of winter injury to fruit trees, the reader is referred to Walte, M. B., *Fruit trees frozen in 1904*. U. S. Dept. Agr., Bur. Plant Indus. Bul. 51, p. 15-19. 1905.

¹⁵ The condition here described was first reported by the senior writer under the name dieback. See McMurrin, S. M., *Notes on pecan diseases*. In *Amer. Nut Jour.*, v. 4, no. 6, p. 81, 86, illus. 1916. The trouble is identical with the disease described by Hartig as staghead, and it appears desirable to use the term already associated with this type of disease. (Hartig, R. *Text Book of the Diseases of Trees*, p. 270. London, 1894.)

both tip and margin, of the leaflets and, if the weather conditions are sufficiently severe, progresses until the whole leaf is dead.

It is of rather common occurrence, but is not serious. It occurs during prolonged periods of excessively hot, sunny days. No actual measurements have been made or experiments conducted to prove that this trouble is due to excessive evaporation, but the writers' knowledge of similar trouble on other plants and the known conditions under which they have observed it on the pecan convince them that it is due to excessive evaporation occurring under the conditions above stated.



FIG. 17.—Typical cases of kernel spot.

DISEASES DUE TO UNKNOWN CAUSES.

KERNEL SPOT.

Typical cases of kernel spot are shown in figure 17. This is a trouble which occurs principally on thin-shell pecans. It is found quite as frequently on the nuts produced by native seedling trees of the Southwest as on those from planted orchards. The spots develop toward the last of the growing season, after the kernels are almost mature, but no evidence of the disease can be seen until the kernels are removed from the shells.

In some preliminary investigations Rand¹⁶ found a fungus associated with the diseased kernels. More recently Turner¹⁷ has suggested that certain sucking insects may be the cause. Pecan growers at various points in the South have stated repeatedly to the writers that the appearance of sucking insects during the summer is invariably followed by a more or less seriously affected crop of nuts. The most that can be said at this time is that the disease is a matter for further investigation, and until the cause is definitely determined no recommendations for its control can be made.

It is difficult to estimate the extent of this trouble, on account of the fact that the pecans from planted orchards do not go to the crackeries, but are widely distributed in the shells to consumers. The disease is more serious in some seasons than others, and occasionally orchards produce a crop of nuts a large proportion of which is affected, but these cases are rather uncommon, and so far as the writers have been able to learn, the disease is not increasing. Fur-

¹⁶ Rand, F. V. Some diseases of pecans. *In Jour. Agr. Research*, v. 1, no. 4, p. 303-338, 5 pl. 1914.

¹⁷ Turner, W. F. *Nezara viridula* and kernel spot of pecan. *In Science*, n. s., v. 47, p. 400-491. 1918.

ther investigations doubtless will throw sufficient light on the cause of these spots to make possible the development of preventive measures.

BLACK-PIT.

The first observable stage of black-pit consists of an internal browning of the nut and a disorganization of the internal tissues with no external evidence of the trouble, as shown in figure 18. The dead, brown internal tissues are surrounded in the beginning by a husk that is green and apparently normal in every respect. No evidence of infection or injury of any sort is to be found on the outside of the nut in the early stages of the disease. However, as the disease progresses the nuts take on the appearance shown in figure 19. Sunken, glossy black spots and blotches appear, and shortly thereafter the nut falls to the ground. This disease usually appears about midsummer.



FIG. 18.—An early stage of black-pit. The internal tissues are brown and disorganized, but the surrounding husk is still green and shows no sign of injury.

The disease is much more serious in some years than others. Taking year with year, however, it can not be said that black-pit has been a source of serious loss. The writers have observed that in seasons of light occurrence the trouble usually affects only one or two nuts in a large cluster, thus suggesting a sort of natural pruning by which the number of nuts in a cluster is reduced. This is not always the case, however, for individual nuts showing the trouble can be found. It remains for further investigation to throw light on this very obscure disease;



FIG. 19.—A later stage of black-pit. The nuts fall from the tree soon after the sunken black spots and blotches appear on the husks.

but there is no reason to suppose that it will become more serious in the future than it has been in the past.

SURFACE GROWTHS ON PECANS.

Very frequently in neglected and occasionally in well cared for vigorously growing orchards, trees will become more or less covered

with nonparasitic superficial growths. Figures 20, 21, and 22 show fungous growths that will be readily recognized by most growers. These growths are entirely superficial and except for marring the



FIG. 20.—The twig on the left is blackened by sooty mold, a superficial growth which discolors the twig but does no harm. The twig on the right is free from the fungus and is presented by way of contrast.

appearance of the trees do little or no harm.

Lichens¹⁸ can be removed by one thorough winter spraying with Bordeaux mixture, and the fungous growths can be scraped off and pruned out. Spanish moss, shown in figure 23, is sometimes found on pecan trees. It is not parasitic, can be easily removed from the tree, and should not be allowed to gain a foothold, on account of its unsightliness and the generally neglected appearance which it gives an orchard.

SPREAD OF PECAN DISEASES.

Various writers have suggested that diseases of the pecan may be expected to become much more serious in time. This belief is based on the known fact that plant diseases of slight importance have sometimes increased in seriousness as the number of host plants in groups increases, thus increasing the opportunity for dissemination. This view overlooks the important fact that the pecan has always grown in groups. In native pecan groves the number of



FIG. 21.—A black fungous growth frequently found on pecan trees. This growth is entirely superficial and does no harm.

¹⁸ Waite, M. B. Experiments with fungicides in the removal of lichens from pear trees. *In Jour. Mycol.*, v. 7, no. 3, p. 264-268. 1893.

trees in many cases runs into the thousands, and yet for years they have continued to thrive and bear crops.

The mere transplanting of a tree does not necessarily subject it to a new set of parasites. It may do this, as is attested by conspicuous cases in which American plants transplanted to European soil have become the victims of new diseases, and vice versa; but no such process is taking place in transplanting the pecan within the United States.

So far as the writers are informed such diseases as are known to be caused by fungi or by bacteria may be found throughout the southern pecan belt. It is true that scab is very serious on susceptible varieties planted in regions subject to high humidity and heavy summer rains and is a rare disease in the semiarid portions of the Southwest, but it is also true that the planting of highly susceptible varieties in the humid rainy sections is rapidly decreasing.

Rosette has been a serious factor in the planted orchards of the southeastern portion of the country, but it is practically unknown in the native growth on river-bottom soils. The degree of longitude, however, has not been responsible for this. The disease also occurs in the Southwest if trees are set on unsuitable soils. The prevalence of rosette in the Southeast has been due to the fact

(1) that there have been many more planted orchards there than in other portions of the country and (2) that through lack of knowledge the planters were not sufficiently discriminating as to soils in selecting orchard sites. It can not be said, however, that this disease is increasing, and it is quite reasonable to suppose that with the wide dissemination of the knowledge that the pecan requires a soil of uniform formation and relatively high fertility and moisture-holding capacity, rosette will decrease.



FIG. 22.—An unsightly fungous growth (*Thelephora pedicellata*). It does little or no injury, but mars the appearance of the tree. It may be removed by scraping or by pruning out the affected limbs and twigs.

These facts do not show that pecan diseases are on the increase. On the contrary, they indicate that if due regard is given to the suitability of soils, varieties, and the care of the orchards after they are planted losses from disease may be expected to decrease. Seasonal variations in the occurrence and seriousness of the various troubles will take place, but this is beside the point, and the writers feel that it can be said with confidence that if growers will use discrimination and care in selecting scab-resistant varieties for planting and set such trees only on soils of uniform formation and good fertility diseases need be but a minor consideration.



FIG. 23.—A pecan tree draped with Spanish moss.



FARMERS' BULLETIN 1130

UNITED STATES DEPARTMENT OF AGRICULTURE

CARPET GRASS



CARPET GRASS is the most important grass for permanent pasture in the Coastal Plain area of the South.

Carpet grass is not a native grass, but was accidentally introduced from tropical America before 1830 and has spread generally over the Southern States.

Carpet grass requires a moist or at least not droughty soil and succeeds better in such soils if sandy than any other pasture grass. The minimum temperature it will survive is about 10° F.

Carpet-grass pastures are readily established in tilled land by seeding at any time from early spring to late summer on a well-firmed seed bed, when moisture conditions are favorable. On unbroken or stump land good results can be secured by burning or mowing the tall native grasses, seeding at a favorable time, and then pasturing to keep the native bunch grasses constantly short. Under this treatment the native grasses are eradicated in one or two years and replaced by a pure stand of carpet grass.

The carrying capacity of good carpet-grass pasture is one cow to the acre for the five best months and one cow to 2 acres for three to five months longer.

Dallis grass, lespedeza, white clover, bur clover, black medic, and Augusta vetch are desirable in mixture with carpet grass. Italian rye may be used as a winter mixture, but needs to be sown each fall. Under some conditions redtop should be used to precede carpet grass.

Carpet-grass pastures should be grazed to their capacity, as under heavy grazing the best condition is maintained.

Bitterweed and dog fennel are the only two weeds that seriously invade carpet-grass pastures. During the first two seasons these weeds should be mowed before they ripen seeds. Thereafter they will cause but little trouble, but mowing should be resorted to when necessary.

Seed of carpet grass is easily harvested by mowing and thrashing. Large areas of pure or nearly pure carpet grass occur in several regions in the South.

Up to the present the quantity of seed produced has been only a fraction of that required. A comprehensive plan has been devised to increase greatly the harvesting of seed, as the outstanding need to stimulate a much greater use of carpet grass for pasture is an ample seed supply.

Contribution from the Bureau of Plant Industry

WM. A. TAYLOR, Chief

Washington, D. C.

April, 1920

CARPET GRASS.

C. V. PIPEB, *Agrostologist in Charge*, and LYMAN CARRIER, *Agronomist, Office of Forage-Crop Investigations.*

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VALUE OF CARPET GRASS.

CARPET GRASS, also known as Louisiana grass and by the French inhabitants of that State as *petit gazon*, is the most valuable grass known for permanent pastures on the sandy soils of the southern Coastal Plain region of the United States. Although long since introduced into the country, its high value has been unappreciated. The reasons for this are not clear, but may be ascribed partly at least to the fact that until very recent years improved pastures in the South were not properly appreciated. Furthermore, carpet grass has been confused with several other more or less similar grasses, and in the belief that it was a native grass has been left like the others to shift for itself.

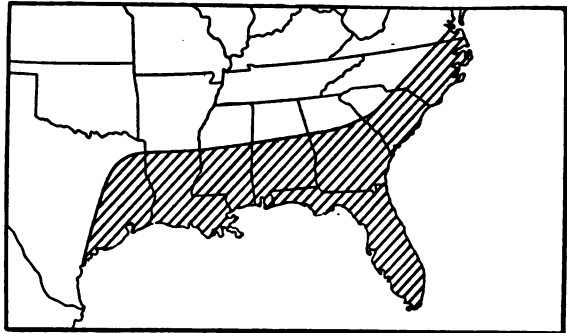


FIG. 1.—Map of the southern United States, showing the distribution of carpet grass.

Extensive observations on carpet grass and the data derived from careful farmers who had learned from experience the value of this grass lead to the conclusion that under conditions suitable for its growth it is at least equal to Bermuda grass in carrying capacity and feeding value and will thrive on soils where Bermuda grass can be made to succeed only by the use of fertilizers.

It is estimated that at least one-third of the Coastal Plain area of the Southern States will grow excellent carpet grass (fig. 1). Fur-

thermore, by the use of this grass most of this area can be developed into admirable permanent pastures without removing the stumps from the land. Land thus improved will support many times the live stock that now exist on the native ranges.

The natural grasses of the Coastal Plain do not furnish good pasturage. They are mainly broom sedge (various species of *Andropogon*) and wire-grass (a name indiscriminately applied to several wiry, slender-leaved, tough grasses, the most widespread of which is *Aristida gracilis*). These grasses are burned off nearly every winter when dry. From early spring to midsummer the young growth furnishes very good pasturage, from midsummer till frost the animals gain slowly if at all, but from frost until the following spring they become greatly emaciated. Much of this very poor natural pasturage can be replaced cheaply by excellent high-grade pastures with carpet grass as the basis. For this purpose carpet grass is of outstanding importance.

Probably carpet grass has not invaded the open ranges of the Coastal Plain to a greater extent mainly because of light grazing and annual fires. Light grazing permits a large growth of tall native grasses which by shading prevent any vigorous growth of carpet grass, and, when burned, make so strong a fire that all carpet-grass plants are destroyed.

DESCRIPTION.

Carpet grass (fig. 2) is a perennial pale-green grass, spreading by creeping stems which root at every joint, thus forming a close, compact turf. The stems and sheaths are compressed and thus two edged, and this character taken with the blunt leaf tips will distinguish carpet grass from most others (fig. 3). The seed stems are very slender, two or three jointed, and 12 to 24 inches high. Very often two flowering branches arise from the sheath of each stem leaf. Each stem bears two or three, rarely four or five, slender spikes of flowers, which later form very small seeds. Flowering stems are produced almost continuously from early spring until frost in the fall.

Young plants begin their growth in a more or less circular small patch and quickly send out runners in all directions. Under favorable conditions, when without competition from other plants, a single plant in a single season will spread so as to form a circle 2 or 3 feet in diameter and produce abundant flowering stems.

Carpet grass never becomes troublesome as a weed, and when its eradication is desirable it is very easily destroyed by plowing it under.

HISTORY.¹

Carpet grass was probably first recorded from Jamaica by Sloane in 1696. Previous to 1830 it is recorded from Peru, Chile, Brazil, Mexico, Haiti, San Domingo, and Porto Rico. More recent collections show it to be native throughout the West Indies and from Mexico southward to Argentina and Chile. In the United States its present distribution is shown on the map (fig. 1). The oldest specimen from the United States is apparently one collected by Drummond at New Orleans in 1832. An earlier record by Rafinesque is clearly based on a misidentification, as his grass was 6 feet tall. The next older specimen was not collected until 1869. It was not found by Elliott around Charleston, S. C.,



FIG. 2.—Carpet grass (*Axonopus compressus*): 1, A plant with nearly mature seeds, the upper part of the stems bent downward; 2, a portion of a spike enlarged; 3, a mature fruit enlarged; 4, the junction of the sheath and blade, showing the eyelashlike ligule; 5, a cross section of the stem, showing how it is compressed.

¹ This grass was first named by Swartz in 1788 from Jamaica as *Milium compressum*; from South America in 1791 by Lamarck as *Paspalum tristachyon*; from Porto Rico by Poiret in 1804 as *Paspalum platycaule*; and from Tropical America by Flüge in 1810. The three plants are indistinguishable. In the older literature it appears commonly as *Paspalum compressum* (Swartz) Nees. The name now used by most botanists is *Axonopus compressus* (Swartz) Schlechtendahl, but some authorities use *Anastrophus compressus* (Swartz) Beauvois. All of these names refer to one and the same grass.

in 1821, nor by Michaux in North Carolina in 1803. A careful study of carpet grass and its behavior indicates clearly that it is not a native in the United States. The plant is never found remote from civilized habitations even in favorable places where annual fires can not be the explanation for its absence. Furthermore, like other introduced plants, such as Bermuda grass and lespedeza (Japan clover), its ability to spread aggressively is a phenomenon rarely found in a native grass.

Carpet grass also occurs in Java, Sierra Leone, and Singapore. It seems safe to say that carpet grass was introduced in the United



FIG. 3.—A sod of carpet grass, showing the compressed stem and broad leaf tips. These characters are very useful in identifying the grass.

States at New Orleans about 1830 and by 1880 was widespread in the Southern States, occurring at that date in Louisiana, Texas, and Florida.

Previous to 1890 carpet grass was known as Louisiana grass, but since then the name carpet grass has become general. Among the Creoles the name *petit gazon* is in frequent use. Unfortunately, the name carpet grass is also applied, especially in Florida, to any broad-leaved grass, such as various native species of *Paspalum*, but the true carpet grass can readily be distinguished by the blunt leaf tips and compressed stems.

SOIL AND MOISTURE RELATIONS.

Carpet grass will thrive on any type of soil if the moisture conditions be favorable, but, like other plants, it grows better on rich than on poor soils. It is remarkable, however, for its ability to grow on poor sandy soils, thriving under such conditions far better than does Bermuda grass. Even on many alluvial soils, as in the lower Mississippi Valley, carpet grass will gradually crowd out Bermuda grass. The latter, however, will grow under more droughty conditions than will carpet grass. Where the ground-water level is only a few inches from the surface carpet grass grows luxuriantly, but it is equally good on well-drained hilly lands with a clay subsoil that prevents their becoming too dry. The ideal condition for carpet grass is a water table only 1 or 2 feet below the surface. Large areas of such lands make up the so-called flatwoods. Carpet grass is not injured by ordinary floods, but quickly renews growth when the water subsides. Thorough compaction of the soil seems very important for carpet grass, and it is rarely found growing where the soil is loose.

Carpet grass seems entirely indifferent to lime, growing equally as well on "acid" soils as it does along the borders of shell roads. Actual field tests have shown no noticeable result from the use of lime.

TEMPERATURE ADAPTATIONS.

Carpet grass is of tropical origin. Its northern limits indicate that it can rarely survive a winter temperature lower than about 10° F. It certainly will not withstand conditions so far north as does Bermuda grass, probably because all of its stems are above ground, and Bermuda grass possesses underground stems that are protected. On the other hand, the leaves of carpet grass are not injured by frosts that completely kill the leaves of Bermuda grass, and furthermore carpet grass greens up in mild winter weather much more than does Bermuda grass. For these reasons carpet grass may be grazed considerably later in the fall and earlier in the spring.

ESTABLISHING CARPET-GRASS PASTURES.

On cultivated land, carpet grass succeeds best on a well-firmed seed bed. The seed may be sown any time from early spring till after midsummer when the moisture conditions are favorable. To secure a full stand of the grass promptly, seed should be sown at the rate of 10 pounds per acre. A method of seeding that has often been used is to cut grass with mature seed and scatter the hay over the land where it was desired to establish carpet-grass pasture. Many writers have advocated planting the grass vegetatively as Bermuda grass

is propagated, but the expense of this method has discouraged its employment.

It is frequently desirable to establish carpet-grass pasture in open forests or on cut-over land, without going to the expense of clearing. To do this all the standing trees should be deadened by girdling. The land to be seeded should be burned over in winter in order to remove all the tall straw of broom sedge, wire-grass, and other bunch grasses. Plowing or disking is not necessary, and the available evidence does not indicate that it is desirable. As soon as the native grasses begin to grow, animals should be put on the area in sufficient numbers to keep the grass eaten short. Carpet grass at the rate of 5 pounds per acre may then be sown at any time after the weather becomes warm, but preferably when there is ample moisture. Under close grazing most of the native bunch grasses will be killed by the end of the first season and carpet grass will occupy the land. It is not advisable to seed carpet grass indiscriminately on cut-over land. To get good carpet-grass pasture on such lands the rate of grazing must be under control, so that it will be heavy enough to destroy the broom sedge and wire-grass while the carpet grass is getting established. Practically all bunch grasses may be destroyed by continuous heavy grazing, but creeping grasses are not materially injured by such treatment. The trampling incidental to heavy grazing seems also to be an important element in securing good carpet-grass pasture. If lespedeza (Japan clover) is not already on the land it should also be sown, as it succeeds well if mixed with carpet grass. The general plan of converting broom-sedge and wire-grass lands to carpet-grass pastures may thus be summarized:

(1) All brush should be cut and all trees not valuable for timber deadened by girdling.

(2) Burn over the area as cleanly as possible when conditions are favorable. Disking or plowing is not necessary and apparently not desirable. In lieu of burning, close mowing may be used, but this is more expensive.

(3) Limit the area, preferably by fencing, to the acreage that can be kept heavily grazed.

(4) Seed to carpet grass at the rate of 5 to 10 pounds per acre any time after spring weather has begun and moisture conditions are favorable. If not already present, lespedeza should be seeded at the rate of 5 pounds per acre.

(5) Drain by open ditches all areas where water is likely to stand for a considerable time.

(6) Heavy grazing will destroy all bunch grasses in one or at most two seasons, and solid carpet-grass sod will cover the land.

(7) On "flatwoods" and other soils well suited to carpet grass, gallberry¹ and bayberry² often occupy much land. These shrubs may be eradicated by cutting with a brush hook or other device two or three times. Gallberry and bayberry are both so bitter that animals refuse to eat them.

¹ *Ilex glabra*.

² *Myrica* sp.

WEEDS.

Two native weeds in particular, namely bitterweed (*Helenium tenuifolium*) and fennel or Yankee weed (*Eupatorium capillifolium*), are very likely to invade carpet-grass pastures. (Fig. 4.) These weeds should be mowed at least once a season, before they have formed seeds. This is sometimes difficult to accomplish on stump land, and therefore the removal of stumps as promptly as possible is desirable. Goats will keep down fennel to a considerable extent. After two or three seasons further mowing will be unnecessary.



FIG. 4.—The bitterweed shown in the photograph is one of the few weeds that invade carpet-grass pasture. Weeds should be mown before they form seed.

CARRYING CAPACITY.

Good carpet-grass pasture on the evidence available seems little, if any, inferior in value to bluegrass pasture. The experience of careful farmers indicates that the best carpet-grass pasture will furnish grazing for one cow to the acre for about five months each season and for one cow to 2 acres for three or four months longer.

Close grazing is very essential to maintain the grass in the best condition. The trampling by the stock keeps the soil compacted, favoring the spread of carpet grass, and close grazing keeps down the taller growing plants which would injure it by shading.

If a field of carpet grass be left ungrazed after October 1 it will grow quite tall. In the protection thus afforded green leaves will appear through much of the winter and furnish winter pasture. The cattle in eating the green leaves consume incidentally many of

the dry leaves which otherwise they would avoid. Such a field must never be burned over, as fire is very destructive to carpet grass.

OTHER GRASSES TO GROW IN MIXTURE WITH CARPET GRASS.

Carpet grass and Bermuda grass rarely grow together for any length of time. As a rule Bermuda grass prevails on clay soils, while carpet grass dominates on sandy soils. On soils that will grow both grasses it is often economy to seed the two in mixture, but eventually one or the other will occupy the land almost exclusively.

Dallis grass (*Paspalum dilatatum*) usually grows well in carpet-grass sod, and it is a good plan to sow seed of this, especially on the better soils, after the carpet grass is well established. Plowing furrows 10 feet apart and sowing the rather expensive Dallis grass seed in the furrows is a good plan.

North of Florida lespedeza, if not already present, should always be added to carpet grass. It succeeds admirably and adds a desirable constituent to the feed.¹

Carolina clover (a native species), yellow hop clover, and rabbit-foot clover (the last two introduced) are desirable legumes. The first comes in naturally and the other two if introduced spread year by year. Commercial seed of these clovers is not on the market.

Bur clover and perhaps black medic are exceedingly desirable legumes to establish in carpet-grass pasture, where the former often succeeds splendidly and results in a 12-months pasture. Success with bur clover is nearly always conditional on securing abundant inoculation.² Black medic on some soil types may be expected to succeed at least as well as bur clover. Augusta vetch is another exceedingly desirable winter legume for carpet-grass pastures. All of the above legumes reseed themselves naturally.

White clover is also a very desirable constituent in carpet-grass pastures, particularly on moist or rich soils. It will make much feed in the cool season, but becomes dormant or semidormant in summer.

Italian rye-grass sown on carpet grass about October 1 under favorable moisture conditions will make much winter grazing. With this grass, however, it is necessary to seed it every season.

Carpet-grass pasture supplemented by the plants mentioned will make an ideal pasture that can be grazed nearly, if not quite, the entire 12 months.

¹ McNair, A. D., and Mercier, W. B. Lespedeza, or Japan clover. U. S. Dept. Agr. Farmers' Bul. 441. 1911.

² Piper, C. V., and McKee, Roland. Bur clover. U. S. Dept. Agr. Farmers' Bul. 693. 1915.

On low or moist soils, particularly near the northern limits of carpet grass, the first seeding of a pasture either on plowed or unplowed land may well be to redtop. The advantages are that the seed is much cheaper and the 1-year-old pasture is an excellent foundation on which to sow carpet-grass seed. Redtop seed in the area referred to must be sown in the fall or early winter. Pure redtop pastures may be expected to persist two or three years. For permanent pastures the addition of carpet grass is imperative.

SEED CROP.

Carpet-grass seed is in much larger demand than supply at present. Unfortunately, there has never been sufficient seed on the market to allow any extensive sowing of this grass. There is no apparent reason why ample seed to supply all needs should not be harvested. Lack of knowledge on the part of those who have the grass in abundance as to the market demand for the seed seems largely responsible for the deficient supply. Those who have open areas of carpet grass of sufficient extent to justify harvesting the seed never have to sow it. On the other hand, in the localities where the seed is most needed the grass does not exist except in small areas.

Perhaps the most promising location for developing the carpet-grass seed industry is on the alluvial lands of the lower Mississippi Valley. In that region cotton growing has been curtailed to some extent because of the boll weevil, and cattle raising has been substituted. Many of these old cotton fields are now thickly set with carpet grass and an abundant seed crop goes to waste every year.

Carpet grass will form a seed crop in spite of pasturing. The stock graze the basal leaves, while the seed stalks are rarely eaten. Perhaps a larger crop of seed may result if all stock is kept off the field for a few weeks while it is going to seed. This is a point on which there are no data and which needs investigation. Meantime the crop of seed which is produced in addition to the pasturing will pay good returns if harvested. An ample supply of carpet-grass seed is at present a great need in southern agriculture.

Carpet grass begins to mature seed in June, but continues to bloom throughout the summer. The main crop of seed and the only one that will usually pay to harvest is ripe early in September. (Fig. 5.) There is a period of a month or six weeks in the fall when seed may be gathered, but there is considerable loss from shattering if the crop is not gathered when it first becomes ripe.



FIG. 5.—Seeds of carpet grass, enlarged. The small figures in the lower left-hand corner are natural size. [Drawn by F. H. Hillman.]

HARVESTING THE SEED.

Carpet-grass seed shatters easily when ripe. The seeds are small and light, being about the size of timothy seed, and not so heavy. The grass should be cut with a mower and handled as little as possible in order to avoid loss from shattering. The straw should be allowed to become thoroughly dry before attempting to separate the seed.

Much seed can be obtained by beating it out of the straw with a flail on a tight floor or on a large canvas. Where there is a considerable area to be harvested a thrashing machine is desirable. Almost any kind of a thrasher will do this work if equipped with proper screens. An ordinary grain thrashing outfit will answer, but it will require more work to clean the seed from the chaff. The chief danger in thrashing will be from too heavy a blast of air, which will blow the seeds out with the straw. The air intakes to the fan should be reduced to the minimum or the fan cut out entirely. Another source of loss is shaking the separating apparatus of the thrashing machine too rapidly. If this action is very violent the seeds, being light in weight, may not fall through the screens, but pass out with the straw.

CLEANING THE SEED.

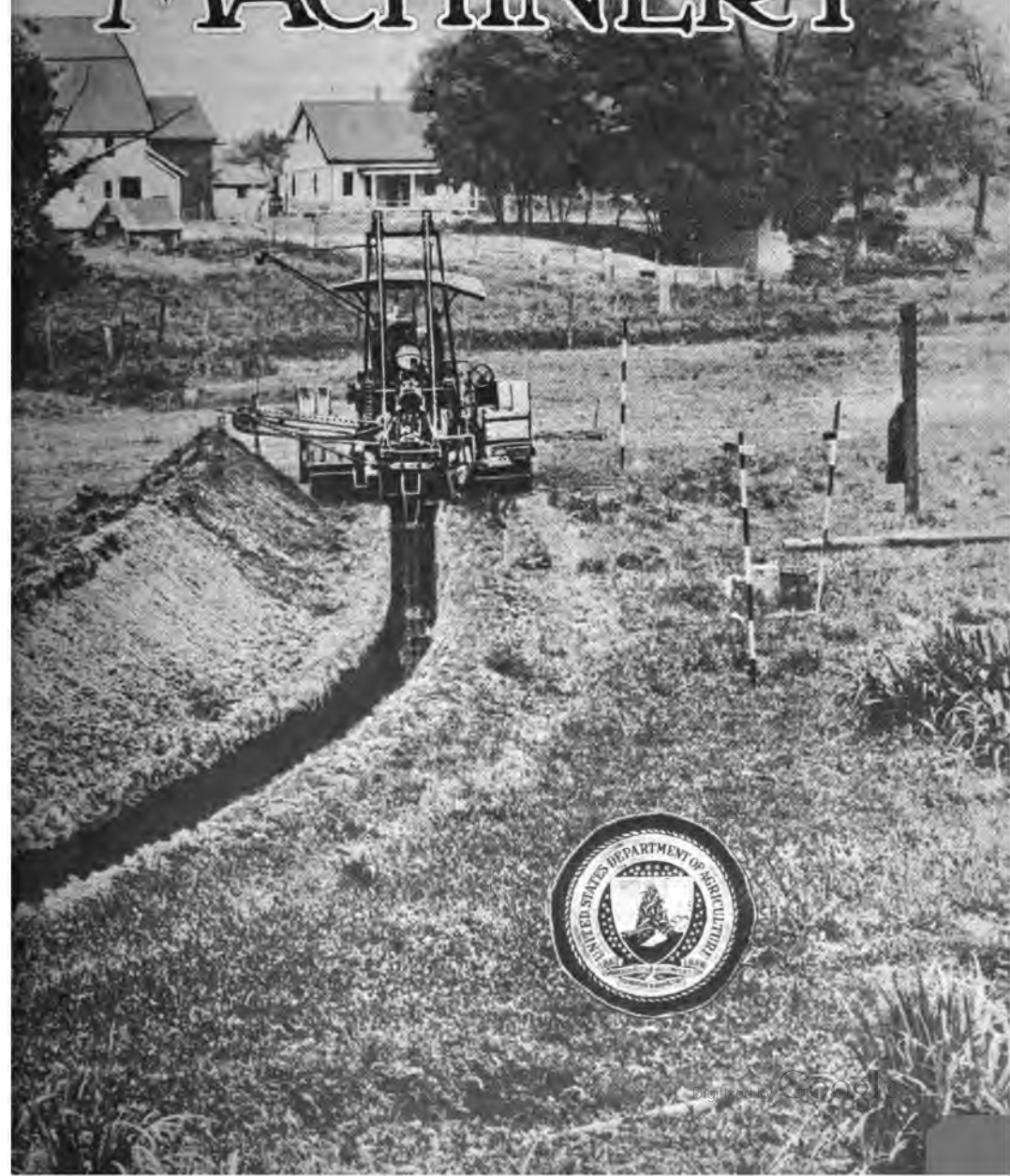
Good screening will clean carpet-grass seed very satisfactorily. A sieve with a mesh one-twentieth of an inch in size will let the carpet-grass seed through and take out the large weed seeds and coarse material. One with a mesh of one thirty-eighth of an inch will hold the carpet-grass seed and separate the finer material. Hand sieves are sometimes used, but the process is slow and laborious. If much seed is to be cleaned a fanning mill is needed. Manufacturers will gladly advise as to the best combination of screens for cleaning carpet-grass seed with their particular machine if a sample of seed is sent to them. In fanning, the air blast must be light in order to avoid loss of seed.

Carpet-grass seed well cleaned weighs about 18 pounds to the bushel.



FARMERS' BULLETIN 1131
UNITED STATES DEPARTMENT OF AGRICULTURE

TILE-TRENCHING MACHINERY



THE MORE EXTENSIVE use of tile-trenching machinery has been brought about by the rising prices and increasing scarcity of labor and the rapid extension of tile drainage for farm lands to increase crop production.

Tile-trenching machinery may be divided into two general classes—horse-drawn ditching plows and power-operated trenching machines.

The ditching plows are comparatively inexpensive implements, costing from \$20 to \$500, which will excavate trenches suitable for the smaller sizes of tile. Hand labor is necessary to grade the trench after using them.

Power-operated machines are of the following general types: Wheel excavators, endless-chain excavators, and those of the drag-line and dry-land, dipper-dredge types. The less expensive power machines, costing from \$2,500 to \$3,500, are used extensively on farm tile drainage. The larger sizes are adapted to contractors' use.

Devices for back-filling trenches range from the ordinary moldboard plow to power-driven back fillers.

The cost of trenching by machinery is not greatly different from that of handwork. The main advantages of machine work over hand labor are the fewer men required and the more rapid completion of the work.

Contribution from the Bureau of Public Roads

THOS. H. MacDONALD, Chief

Washington, D. C.

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TILE-TRENCHING MACHINERY

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THE INVENTION of suitable appliances for tile trenching has been stimulated by various agencies—the rising prices and increasing scarcity of labor, the rapid extension of tile drainage for farm lands to increase crop production, and the growing practice of using large tile instead of open ditches of moderate size for community outlets, especially where the depth of cut is rather great. Where wide trenches are dug by hand deeper than 6 or 7 feet, the material must be handled at least twice, since the dirt can not be thrown back from the edge of the trench at the first handling. Besides reducing the amount and cost of labor, a good machine greatly lessens the time necessary for doing the work, which is often of considerable advantage, apart from any saving in direct money cost. Difficulties such as occasionally arise where many unskilled workmen are employed may be largely avoided by the use of machinery requiring only a small crew. The many types of equipment for trenching vary from horse-drawn machines of small size to elaborate power-driven machines costing thousands of dollars. The various types of ditching plows are limited as to the depth and width of trench they will cut, also in regard to the conditions under which they will work.

REQUISITES OF A GOOD MACHINE

Three things are required of a good trenching machine, namely, (1) it must operate efficiently through various kinds of soil; (2) it must be capable of cutting true to grade; (3) it must work for long periods without breaking or otherwise getting out of order. The first of these requirements is the hardest to fulfill; the second is the easiest.

There are many kinds of soil to be encountered—hard shale, cemented gravel, sand, stones, loose loam, soft muck, and sticky clay.

None of the machines will handle solid rock. The ideal machine will handle all kinds of soil, with but minor changes of parts, without breaking or stopping and at a minimum expense for purchase, operation, repairs, and depreciation. Open or skeleton excavating buckets are best suited to sticky soils, while solid buckets are necessary in loose, dry soils, though some machines have efficient cleaning devices that permit the use of solid buckets for any kind of material. A machine must be strong to work through shale or stony ground, but if increased strength entails added weight, its efficiency and adaptability may be affected. A heavy machine can not work over soft ground unless fitted with rather costly apron tractors instead of the driving wheels. (See fig. 8.)

GENERAL CLASSES OF TRENCHING MACHINES

The many types of trenching machines may be divided into four general classes: (1) Plows and scoops, (2) wheel excavators, (3) endless-chain excavators, (4) scraper excavators. The general nature of the plows and scoops is indicated by their names. They are usually operated by horses, and some merely loosen the dirt to make hand shoveling easier. In the wheel excavators the excavating buckets are arranged upon the rim of a wheel. (See fig. 7.) In the endless-chain excavators the excavating buckets are carried on parallel endless chains supported by a long steel frame at the rear of the machine. One end of the frame is lowered so that the buckets are drawn up the end of the trench, cutting a thin slice of earth from the bottom to the top. (See fig. 10.) The scraper machines are the same as the drag-line machines designed for wide ditches, sometimes with slight changes in the rigging to give better control of the bucket.

The dry-land dipper dredges are of the type ordinarily used in the construction of open ditches. The largest machines of the third and fourth classes are adapted to deeper and wider trenching than are those of the other classes.

In the following descriptions of the various types the letters used to designate the machines have been assigned arbitrarily by the writer for convenient reference. The prices given are those quoted during the summer of 1919.

DITCHING PLOWS¹

This class of excavators has been made to include the smaller and less expensive implements, which will be found economical for smaller jobs than would warrant the purchase of the more costly machines. All the plows are lacking in any device for cutting accurately to grade. Some handwork is necessary to make the trench smooth for

¹ The data on horse-drawn plows have been abstracted from a report by F. F. Shafer, senior drainage engineer, Bureau of Public Roads.

laying the tile properly. Many are limited in depth of digging to 2½ or 3 feet, which in many places is not as deep as tile should be laid. Some of these implements are merely aids to handwork, using animal power only to loosen the dirt. The main advantage over the more elaborate trenching machines is their low cost.. (See Farmers' Bulletin No. 524, for information on digging trenches for small fields entailing handwork.)

The ditching plow is essentially a farm tool, adapted to the needs of the farmer who wishes to drain a portion of his farm. By using plows he can to a certain extent substitute horse power for man power. If the drains are so located that they can be constructed at times when farm work is not pressing, the horses unemployed, and the farm labor free to do most of the handwork, the tiles can be laid quite cheaply. For large jobs, or contract work, hand labor or power ditchers are probably preferable.

The ditching plows will not work on lands so wet or boggy that horses can not be driven over them. In wet, loose, or sandy soils it may be necessary to use extra wide eveners that the horses may walk some distance away from and on each side of the trench, and thus the banks of the trench

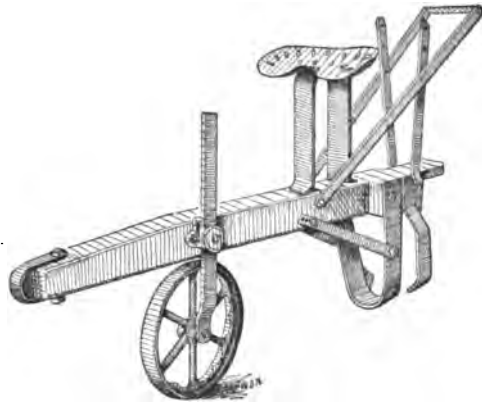


FIG. 1.—Ditching plow A used for loosening soil in trenches.

are not so apt to be broken down. Attempts to use tractors for operating ditching plows have in some instances failed because the weight of the tractor broke down the banks of the trench.

In constructing tile drains it is always desirable to open up only a comparatively short length of trench at one time, for if bad weather occurs the walls of the trench are apt to cave or wash, and much additional labor will be required to get the trench in condition to lay the tile. If, however, the plow is to be used to the best advantage, it is necessary to open up the entire length of a drain, or possibly several drains at one time. Tile should always be laid and blinded as fast as the trenches are finished to grade.

DITCHING PLOW A

Perhaps one of the simplest trenching devices is the ditching plow shown in figure 1, which is used only to loosen the dirt in order that shoveling may be easier. The U-shaped knife does most of the

cutting; the side knives just behind keep the sides of the trench vertical. Each plowing cuts from 1 to 6 inches deep, depending upon the hardness of the soil. After each round of the plow the loosened material is thrown out with shovels. The usual width of the trench is about 12 inches, but the side knives may be spread to cut 16 inches wide. This plow weighs about 165 pounds and costs about \$20. It is drawn by two horses. One man holds the plow and another drives the team. The trench must be graded with hand labor.

DITCHING PLOW B

Figure 2 shows another ditching plow for merely loosening the soil. The first furrow along the trench is made with an ordinary plow, then the ditching implement is used. This plow has no moldboard, and the share cuts 6 inches wide on the bottom. An adjustable slider in front of the plowpoint regulates the depth of each cutting. The plow beam is adjustable vertically, being pivoted on the front arm of the standard and held in the desired position

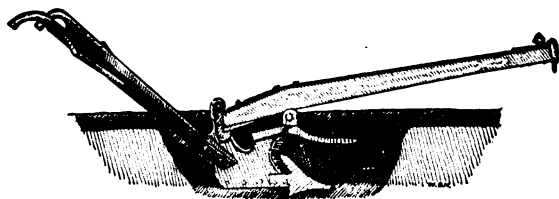


FIG. 2.—Ditching plow B for loosening soil in trenches.

by a segment at the rear end of the beam. The first round of this plow cuts the sides of the trench straight down. The loose earth is then shoveled out, the plow beam is raised,

and another round is made. This process is repeated until the desired depth is reached. The minimum width of trench is 8 inches, and the plow works in this width to 3 feet deep without difficulty. Wider trenches can be cut deeper, though it may be necessary to lengthen the distance between the plow and the team. An attachment is made for cutting a smooth groove in the bottom of the trench, in which to lay the tile, but there is no way of cutting to grade with this implement, and the trench must be finished with hand labor. The plow weighs about 150 pounds and costs about \$20. It is drawn by two horses. One man is required to drive the horses and one to handle the plow.

DITCHING PLOW C

Ditching plow C (see fig. 3) is mounted on wheels; the two smaller wheels run in the trench and the two larger ones straddle the trench. At the point of the plow is a U-shaped cutting bail which shapes the trench. The earth is pushed up the moldboard to the top of the trench on the right side only, while an extended wing on the left side drags the dirt back from the trench on the return trip. The dirt is removed by driving back and forth on the trench. The full depth

of the trench is not made at one cutting, but from 1 to 6 inches is removed at each passage. The trench is 12 inches wide and the maximum depth possible is 3 feet. From four to six horses and three men are required to operate the plow. The machine will cut about



B.P.R. D-3283

FIG. 3.—Ditching plow C for constructing trenches not more than three feet deep.

150 rods of trench, from 24 to 30 inches deep, in 10 hours. Hand-work is required to finish the trench to grade for laying the tile. The implement weighs about 1,200 pounds and costs \$300.



B.P.R. D-3441

FIG. 4.—Ditching plow D for constructing trenches up to three feet deep.

DITCHING PLOW D

At first glance ditching plow D (fig. 4) looks something like a wheel excavator, but it is merely a plow fitted with a wheel and belt for

lifting out of the trench the dirt loosened by the plow. The plow is located under the rear of the elevating wheel, which bears the entire weight of the machine when working. The frame of the machine is lowered until the plow cuts a slice of earth 1 to 6 inches thick, according to the kind and condition of soil. The driver from the rear seat controls the thickness of this slice by levers that change the distance of the plowpoint from the rim of the elevating wheel. This wheel has a wide rim, with flanges about 3 inches deep, between which the 8-inch link belt fits easily. The elevating wheel is revolved by friction on the ground, and drives the link belt by means of a chain connection. As the dirt is loosened by the plow it is caught between the wheel and belt and is carried to the top of the machine, where it is forced off the wheel upon a dirt board that drops it beside the trench. The flanges of the large wheel act as rolling cutters in trimming the sides of the trench. The belt is kept taut by a small movable pulley and a steel spring under the rear driving seat. When one slice has been taken from the bottom of the trench, the frame of the machine, with plow, wheel, and belt, is further lowered and another slice is cut. This process is continued until the trench is as deep as is desired, or until the maximum depth that the machine will cut (36 inches) has been reached. Handwork is required to bring the trench to exact grade.

Operated in the manner described, this excavator will dig a trench about 10 inches wide, or wide enough for 6-inch tile. The machine can be equipped with two trimming knives for cutting wider trenches. These knives are made in different sizes, for digging trenches up to 16 inches wide. As the trimming knives are behind the plow the dirt which they loosen is not removed until the machine makes the next cut through the trench. The dirt board may be raised or lowered to regulate, in a measure, the distance at which the excavated material is placed from the trench. Usually one man and four horses are needed for operating this plow, although sometimes an extra man is needed for driving until the horses become accustomed to the work. An average day's work with this machine would be about 150 rods of trench, 30 to 36 inches deep. The excavator weighs about a ton and costs \$325.

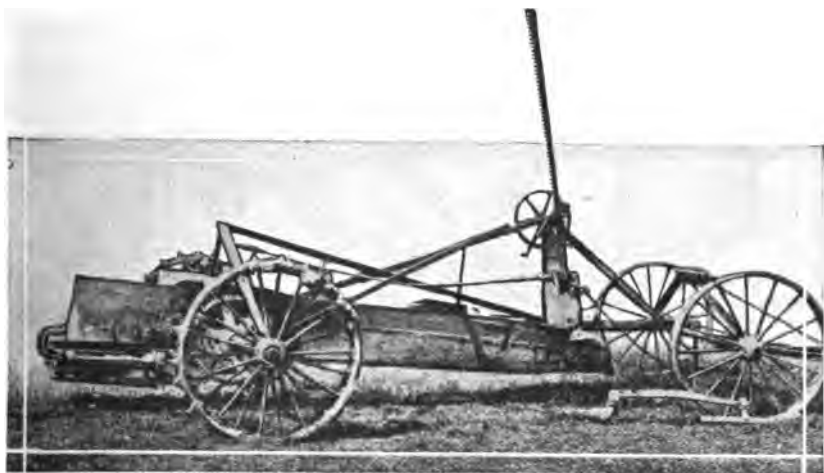
DITCHING PLOW E

The mechanism of ditching plow E (see fig. 5) consists of a long, inclined U-shaped trough, in which travels a metal continuous-chain dirt carrier. Attached to the front end of the trough is a steel U-shaped cutting bail which does the digging. The cutting edge is raised and lowered in a vertical line by a graduated iron rod. One edge of the rod has a rack into which meshes a gear operated by a

handwheel. A change of position of the cutting bail one notch represents one-tenth of a foot.

The back end of the dirt carrier is supported by the rear axle of the machine, which furnishes the power to elevate the dirt. The earth is dumped from the inclined carrier onto a short side carrier which deposits it one side of the trench. The driving power for the elevating carrier and the delivery conveyor is obtained from the rear wheels of the machine, these wheels being equipped with lugs to prevent slipping. The wheels have a tread of about 10 feet to permit them to travel outside of the dirt removed.

The dirt is removed by driving back and forth over the trench, cutting from 3 to 6 inches at each cut. The machine will cut a trench 12 inches wide and of any depth up to 54 inches. Three men and from six to eight horses are required for operating the machine.



B.P.R. D-1062

Fig. 5.—Ditching plow E which will construct trenches not exceeding 54 inches deep.

The implement has no device for cutting to an accurate grade; consequently some handwork is required to finish the trench to exact grade. This plow under average working conditions will dig about 150 rods of trench, 3 feet deep, in a day. The price is approximately \$500.

WHEEL EXCAVATORS

COMMON FEATURES

The wheel excavators generally have steel bed frames, rigidly braced, upon which the power equipment is mounted. Internal-combustion engines burning gasoline, kerosene, naphtha, or alcohol are perhaps most generally used, though steam engines and boilers are often preferred. The internal-combustion engines are preferable where it is important to avoid unnecessary weight.

The machine usually is supported upon two pairs of wheels, the front pair with flanges to prevent slipping sidewise from the line of the trench. The rear wheels carry most of the weight and therefore are large and broad. Many manufacturers now fit their machines, especially the heavier ones, with what are known as apron or caterpillar tractors (see figs. 7, 8, and 10) instead of rear wheels. Each of these tractors consists of a series of wooden or iron crosspieces carried by parallel endless chains about a steel frame in such manner that the weight of the machine rests upon several crosspieces; the large bearing surface thus obtained will support the machine upon very soft ground. As the excavator moves forward the chains lift the crosspieces at the rear and carry them to the front of the tractor.

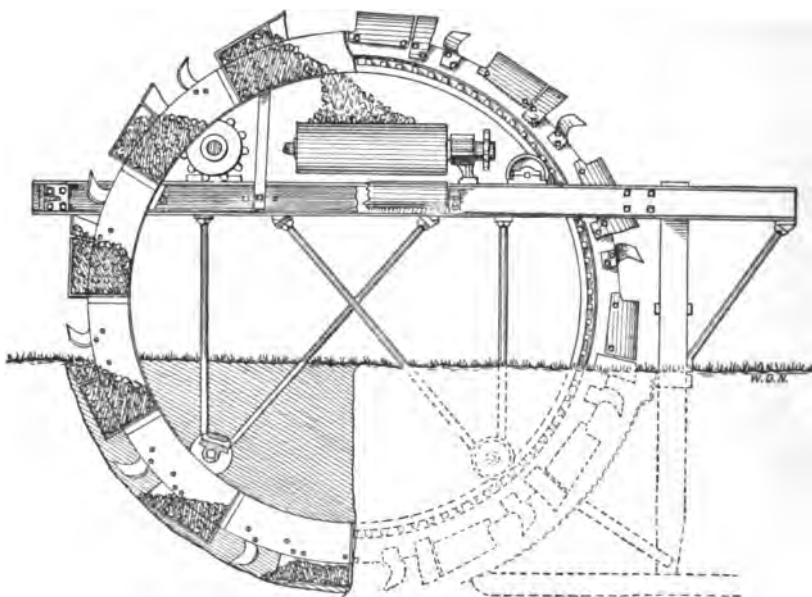


FIG. 6.—Digging mechanism of a common type of wheel excavator.

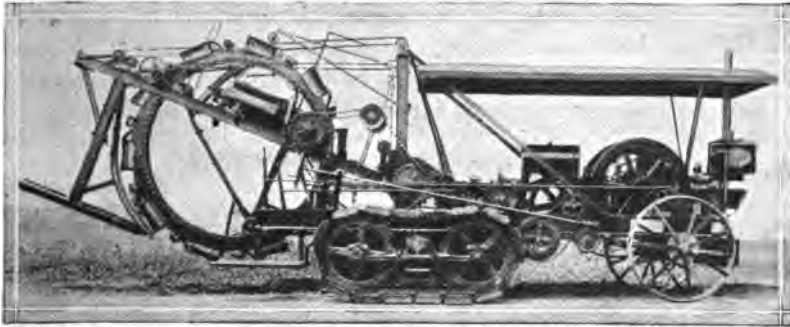
Most machines move by applying power directly to turn the rear wheels or tractors. In soft soils, when power is applied to the wheels or tractors, these often slip and the consequent "churning" causes the trench banks to cave and the machines to settle deep into the ground. When a tile-laying shield must be used the amount of power necessary to move the machine may make it difficult to apply power directly to the tractors on the very large machines, in which case it may be advisable to pull the machine ahead by a cable anchored to a "dead man." By pulling the machine ahead the load on the ditch bank is decreased, which may prevent caving of soft soils.

The digging is done by buckets upon the rim of a wheel that is revolved in the trench (fig. 6), and as each bucket reaches the top

of the circle the dirt falls upon a conveyor belt that can be shifted to deposit the spoil upon either side of the trench.

Lever's are so arranged that the depth of excavation can be accurately controlled by the person operating the machine. An arm or gauge is attached to the digging frame in such a way that the operator can sight across it to targets set along the line of the trench at a known height above the desired bottom, and can thus cut true to grade.

For work in soils so soft that the sides of the trench will not stand unless supported, some machines may be fitted with shields following close behind the digging apparatus, which keep the trench open until the tile can be placed in position. (See fig. 8.) The shields for the smaller machines are usually about 8 feet long, just sufficient to permit a man using a tile hook to lay the tile properly. The use of the shield, of course, increases the amount of power necessary to draw



B.P.R. D-3288

FIG. 7.—Wheel machine F equipped with a one-cylinder, internal-combustion engine, and apron wheels. This size of machine cuts a trench 11½ inches wide, 4½ feet deep at one operation.

the machine ahead. The caving earth frequently causes the last-laid tile to "creep" forward with the machine, leaving an opening between tiles where much dirt might get into the drain and choke it. To prevent this creeping, the man laying the tile must hold the tile in place until it has left the shield. The shields on the large machines are of sufficient width for a man to work in them.

Unstable soils often cave in at the sides of the digging wheels. To prevent this the manufacturers provide a casing for the digging wheel. (See fig. 8.) The additional cost of such a wheel casing is often justified, since it prevents the earth from caving into the trench at the wheel.

MACHINE F

The machine of this class in most common use (see fig. 7) has an open excavating wheel; that is, a wheel with neither spokes nor hub. This wheel consists of two parallel iron rims held in their proper

relative position by the buckets, which are fixed between the rims and firmly riveted to them. The rims are supported upon four pairs of small wheels (see fig. 6.) Both wheels of the pair just above the point where the digging is done are sprocket wheels, through which the power is applied. The buckets are open at the inner side, but close inside the rims is a metal plate extending nearly one-half the circumference of the excavating wheel that keeps the dirt in the buckets until it has been carried to the highest point; there it falls upon a belt conveyor, which deposits the spoil beside the trench. Between the buckets, which have semicircular cutting edges, side cutters (see fig. 6) are bolted to the wheel for cutting the trench a little wider than the buckets, thus reducing the friction. The front end of the frame carrying the excavating wheel is hinged to the rear of the platform carrying the power equipment; the rear of the frame is supported on a shoe that slides on the bottom of the trench and makes a smooth, shallow groove for the tile. The maximum depth of digging is about two-thirds the diameter of the wheel. Solid buckets are used for digging light or sandy soils and skeleton buckets for the wet and sticky soils, as the latter buckets are easier to clean. A cleaning device is furnished to remove sticky earth from the buckets.

This machine is made in several sizes, and digs trenches ranging from 11½ inches wide by 4½ feet deep to 18 inches wide by 6½ feet deep. The weights and approximate selling prices for this machine, equipped with internal-combustion engines and wheel traction, are as follows:

Sizes, weights, and costs of machine F

Size of trench.	Power equipment.	Weight (tons).	Price.
11½ inches by 4½ feet.....	14 horsepower, single cylinder.....	7½	\$2,550
11½ inches by 4½ feet.....	20 horsepower, 4-cylinder.....	7	3,400
11½ inches by 5½ feet.....	14 horsepower, single cylinder.....	7	2,700
11½ inches by 5½ feet.....	20 horsepower, 4-cylinder.....	8	3,500
15 and 18 inches by 5½ feet.....	20 horsepower, 4-cylinder.....	12	3,800
15 and 18 inches by 6½ feet.....	30 horsepower, 4 cylinder.....	13½	4,700

To equip any of these sizes with apron wheels an additional charge of from \$250 to \$300 is made. The trenching shields and the wheel casings each cost from \$35 to \$65 extra. The apron wheels increase the above weights by about 2,500 pounds. The machine is equipped with various gears for regulating the forward movement, which is accomplished by power applied to the rear wheels of tractors. The road speed is about 2 miles an hour. For railroad transportation the wheels or tractors must be removed from the larger sizes.

The cutting speed of these machines varies from 1 to 8 feet per minute. In beginning a trench the forward end of the cutting-wheel

frame should be about $3\frac{1}{2}$ feet lower than the rear end. The traction is then thrown in, and as the machine moves forward the wheel cuts its way forward and downward at this angle until grade is reached. The digging-wheel frame is leveled and grade is maintained by raising or lowering the forward end of the frame by a power hoist. The smaller machines are provided with a friction safety device which slips when an obstacle is met. On the larger machines the multiple-disk clutch forms the safety device. A sight arm is provided for digging to grade. A careful operator can attain very satisfactory grades with this machine. One man is required to operate it.

A large number of these machines have been manufactured and have given general satisfaction under ordinary soil conditions. They have cut tree roots as large as a man's arm. Stones larger than the buckets will be rolled out if found near the surface of the ground, but



B.P.R. D-3286

FIG. 8.—Wheel machine G, equipped with shield and wheel casing for use in caving soil. This size of machine cuts a trench 12 $\frac{1}{2}$ inches to 15 inches wide, 5 $\frac{1}{2}$ feet deep at one operation.

when bedded deeply they must be removed by hand. Ordinarily it is not wise to attempt to cut large roots or remove large stones with the machine, as it strains it unnecessarily.

MACHINE G

A type of wheel excavator which has buckets somewhat different from those of machine F is manufactured (see fig. 8). Each of the buckets is a broad, low T with an arched top, attached by the vertical stem to a rib on the wide rim of the excavating wheel. The buckets are open at the sides. Two stationary cleaners, one on each side at the top of the wheel, scrape the dirt from the buckets onto a belt conveyor, which deposits it on the side of the trench. These buckets were designed for very sticky soils, and for work in loose material are fitted with spring backs. Only one man is required to operate the machine.

This machine is made in several sizes. It digs trenches from 12½ inches wide by 4½ feet deep to 24 inches wide by 7½ feet deep. Its approximate selling prices, when equipped with internal-combustion engine, an apron or corduroy traction, wheel casing, and shield are as follows:

Sizes and prices of machine F

12½ to 15 inches by 4½ feet, 20 horsepower 4-cylinder engine.....	\$5,000
12½ to 15 inches by 5½ feet, 20 horsepower 4-cylinder engine.....	5,500
15 to 21 inches by 5½ feet, 24 horsepower 4-cylinder engine.....	6,000
15 to 21 inches by 6½ feet, 30 horsepower 4-cylinder engine.....	7,500
20 to 24 inches by 7½ feet, 45 horsepower 4 cylinder engine.....	10,000

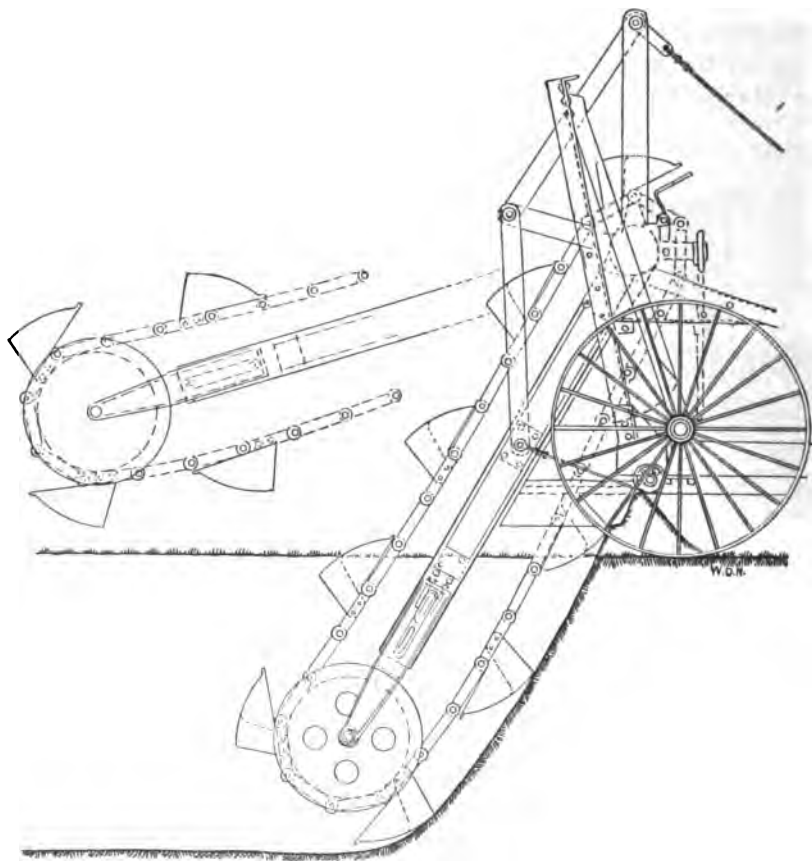


FIG. 9.—Digging mechanism of a common type of endless-chain excavators.

ENDLESS-CHAIN EXCAVATORS

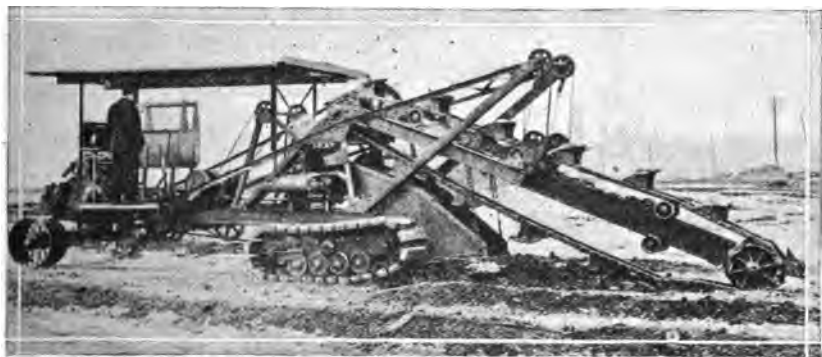
This class of excavator, like the wheel machines, has a steel bed frame mounted upon two pairs of wheels and carrying steam engines and boilers or internal-combustion engines. Apron tractors are often used instead of the rear wheels. The digging apparatus is operated by a wheel at the upper end of the frame, receiving power through a

chain or belt drive from the engine (see fig. 9). At the end of their upward movement the buckets empty their loads upon an endless belt, which conveys the dirt far enough to the side that it will not fall back into the trench. Cutting knives or teeth on the lip of the bucket are often used in hard ground.

Devices for cleaning the buckets are provided. The depth of excavation is regulated by levers in the same way as for the wheel excavators. Shields can be used to keep the trench from caving until the tile have been laid.

MACHINE H

This excavator (see fig. 10) carries most of the weight on two tractors, each of 10 to 50 square feet bearing surface, depending upon the size of the machine and the character of the soil. The front wheels guide the machine and carry a little weight. The usual power equipment is a gasoline engine of the vertical, water-cooled



B.P.R. D-2196

FIG. 10.—Endless-chain machine H, equipped with apron traction. This size cuts a trench from 12 to 18 inches wide, 6 feet deep at one operation.

type, with two to four cylinders. This is belt-connected to a friction drum, which transmits the power through a heavy sprocket chain to the excavating chain and the belt conveyor. The gasoline and water tanks are located ahead of the engine on the front of the bed frame. The machine moves forward by power applied directly to the tractors. Its average road speed is about 2 miles per hour. The manufacturers of this machine provide a device that prevents soft earth from working up between the boards forming the bearing surface of the tractor, eliminating a source of annoyance not uncommon to apron tractors generally. The excavating buckets are of the open, conical-scoop shape; and as each revolves about the driving wheel it is scraped by a cleaning device that causes the dirt to fall upon the belt conveyor. This conveyor can easily be shifted from one side to the other, permitting the dirt to be piled on the side preferred.

The machine is made in two sizes, the smaller digging 12 to 18 inches wide and any depth not exceeding 6 feet, the larger digging 15 to 24 inches wide and any depth to 10 feet. The operator can adjust the width of the trench merely by changing the knives or reamers used with the buckets. The smaller machine weighs about 9 tons, is fitted with an 18-horsepower gasoline engine, and costs about \$7,500. The larger machine equipped with a 20-horsepower steam engine, weighs 15½ tons and costs \$8,350. It may also be equipped with a 36-horsepower, 4-cylinder gasoline engine, the price with this power being \$8,900. Only one man is needed to operate the machine.

MACHINE I

Another machine of the endless-chain type is shown in figure 11. This machine cuts a trench from 15 to 24 inches wide and any depth not exceeding 10 feet. The machine is equipped with tractors and is operated by a 28-horsepower, 4-cylinder gasoline engine. The road



B.P.R. D-3289

FIG. 11.—Endless-chain machine I, boom in position for traveling. This machine digs 15, 18, and 24 inches wide and 10 feet deep.

speed of the machine is 1½ miles per hour and the digging speed from 8 to 10 feet per minute. The machine can be shipped without dismantling on one flat car. A grading device is furnished for cutting the trench to the desired grade. Only one man is required to operate the machine. The excavator weighs 8½ tons and costs \$6,800.

MACHINE J

A noticeable feature of this machine is that a third pair of wheels is used to support the rear end of the digging apparatus. (See fig. 12.) When working, the rear wheels are spread wide apart, so that the truck straddles the trench and the waste banks. For road travel and for railroad transportation the rear truck is narrowed to the width of the others. The front end of the frame supporting the buckets and the greater part of the weight of the power machinery is carried on the two large wheels of the middle truck. The rims of these wheels can be widened by spreaders, permitting the machine to

travel over very soft ground. Both the front and the rear wheels can be steered so that turns of short radius can be made both on the road and when digging. Power is furnished by a gasoline engine. A friction clutch is used to prevent large rocks or other obstructions from breaking the machinery. This excavator ordinarily moves under power applied from the engine to the large middle wheels, but when a shield is used in the trench to prevent caving of the sides the machine is moved by pulling on a cable anchored ahead. The machine can be equipped with apron tractors if desired. The road speed is about $1\frac{1}{2}$ miles per hour. The digging equipment is similar in general to that of excavator H, already described. The buckets are of a special conical shape. The cleaning device is stationary, with a spring that makes the cleaner fit each bucket exactly, and has worked exceptionally well in sticky gumbo soil. There are two

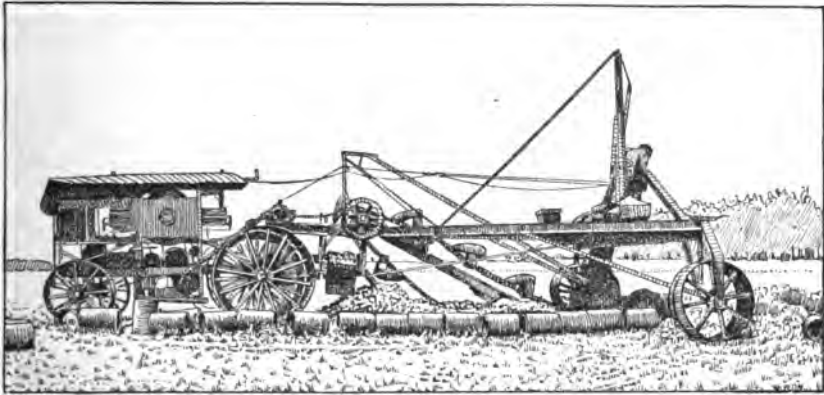
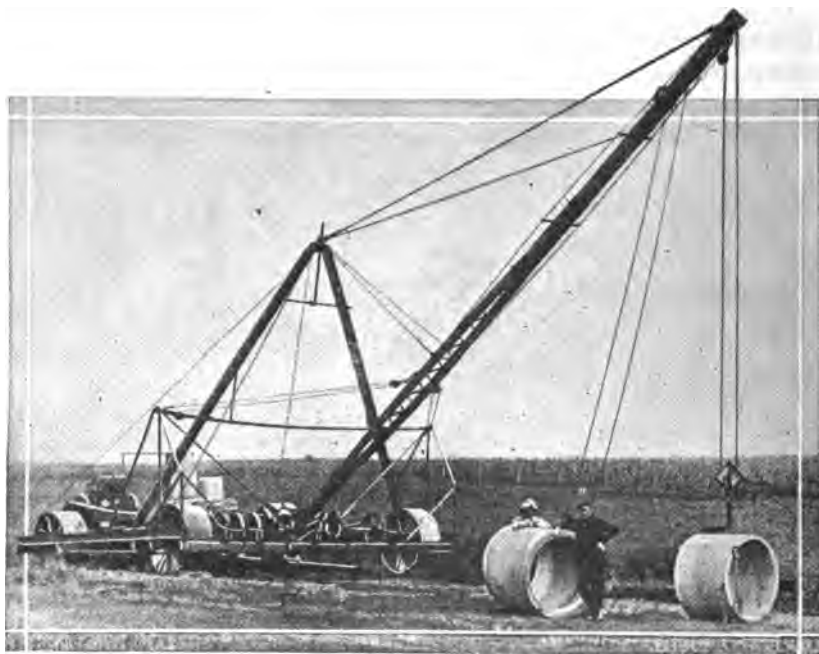


FIG. 12.—Endless-chain machine J equipped with rear trailer which supports part of digging mechanism. This machine cuts a trench 28 to 47 inches wide to depths up to 10 feet.

conveyor belts, one on each side, which meet under the middle of the bucket being dumped. When both conveyors are in a horizontal position the dirt is deposited on both sides of the trench. All may be placed on one side by merely raising the conveyor on the opposite side to a vertical position. The mechanism regulating the depth of cut is mounted upon the trailer frame that connects the rear wheel and the forward part of the machine, and can be operated either by hand or by power from the engine.

The excavator is made in three sizes. The smallest machine cuts 16 to 26 inches wide and to 9 feet deep; weighs about 8 tons; is equipped with a 25-horsepower, 2-cylinder, opposed type, internal-combustion engine and costs about \$5,000. The middle size cuts 28 to 47 inches wide and to 12 feet deep, weighs about 15 tons, has a 40-horsepower engine, and costs about \$8,000. The largest machine cuts 28 to 58 inches wide and to 20 feet deep, weighs about 18 tons, has a 40-horsepower engine, and costs about \$8,500. An extension

for digging deeper than the stated limits can be furnished for the two larger machines. Motor spirits, gasoline, or kerosene can be used for fuel. This machine weighs less than any other practical design, capable of digging to the same limits, that has yet been placed on the market. In the two larger sizes this excavator has a crane mounted on the trailer frame for lifting the tile from the side into the bottom of the trench. The windlass for the crane is usually worked by hand, but it could be operated by power from the engine. The entire trailer with the digging mechanism can be detached by removing one bolt and disconnecting the hoisting cable and the chain driving the buckets. The forward part of the machine then can be



B.P.D. D-3285

FIG. 13.—Scraper excavator K, equipped with $\frac{1}{2}$ cubic-yard bucket and hoist for lifting tile into trench. used as an ordinary traction engine for hauling or other power purposes. To run either of the larger machines two men are necessary—one to operate the traction and one to regulate the depth of cutting and to operate the tile crane.

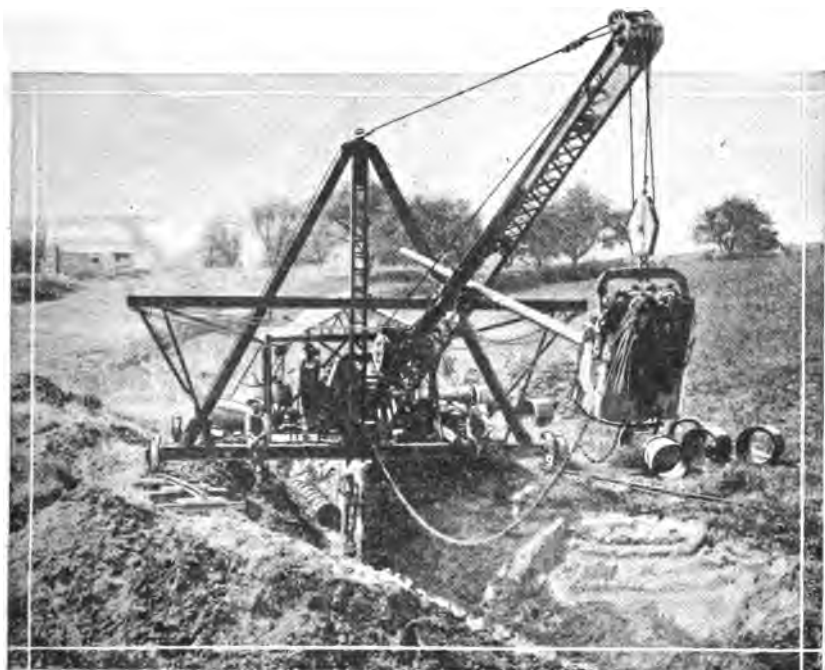
SCRAPER EXCAVATORS

The machines in this class are merely adaptations of excavators originally designed for digging large ditches. They are not suited to trenching for small tile, and are used entirely for large tile mains.

MACHINE K

The illustration (fig. 13) shows a drag-line excavator of ordinary design being used for laying a main drain of very large tile. Upon

the bed frame is mounted a swinging boom, the upper end of which is supported by a cable from the top of the A frame, also mounted upon the bed of the machine. The bucket or scoop hangs on a cable from the upper end of the boom. It is filled by being dragged lengthwise of the ditch by a cable pulling directly from the front of the machine. The loaded bucket is raised by the rope from the boom, which then swings it to the waste bank to be dumped. Another cable from the hoisting engine may be run over a sheave on the end of the boom to lift the tile into place from beside the trench. Either steam or gasoline power may be used to do all the work of digging,



B.P.R. D-286

FIG. 14.—Dry-land dipper dredge L, equipped with one cubic-yard dipper, excavating trench for large tile.

swinging, and dumping the dirt, and of lifting the tile into place. Only one man is required to operate the machine, but a second man is needed to attach the lifting cable to the tile beside the trench, and a third to fit the tile as they are placed in position. This type of machine can not dig to grade accurately, and the bed for the tile must often be smoothed with shovels. The excavator shown in figure 13 costs approximately \$5,500.

MACHINE L

Frequently the dry-land dipper dredge (fig. 14) is used for excavating trenches for large tile. This type of machine may be mounted either on track, as in figure 14, or on the walking device. The ma-

chine is made with various spans from 14 feet to 45 feet, and with booms from 24 to 45 feet long. It is designed for two sizes of buckets, one-half cubic yard and one cubic yard. The dredge is



FIG. 15.—Backfilling a tile trench with team and plow.

B.P.R. D-2393

operated by an internal-combustion engine. With the track dredge two men are required for operation—one operator and one trackman. Only one man is required to operate the machine equipped with the walking device.



FIG. 16.—Backfilling a tile trench with team and small road grader.

B.P.R. D-3290

BACK-FILLING DEVICES

For back filling the trench both horse-drawn and power-operated implements may be used. For the smaller and shallower trenches

the common method is by means of an ordinary moldboard plow (fig. 15). The V-shaped drag operated by horses may also be used. By driving back and forth along the trench the material is dragged

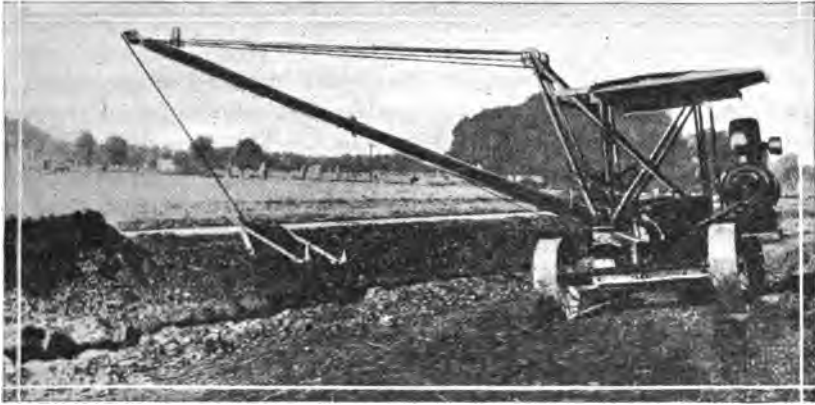


FIG. 17.—Power-operated backfiller filling a large tile trench. B.P.R. D-3291

back into the point of the drag and drops into the trench. The common slip scraper is occasionally used to back-fill trenches. A road grader or a steel-bladed scraper (see fig. 16), which is mounted on

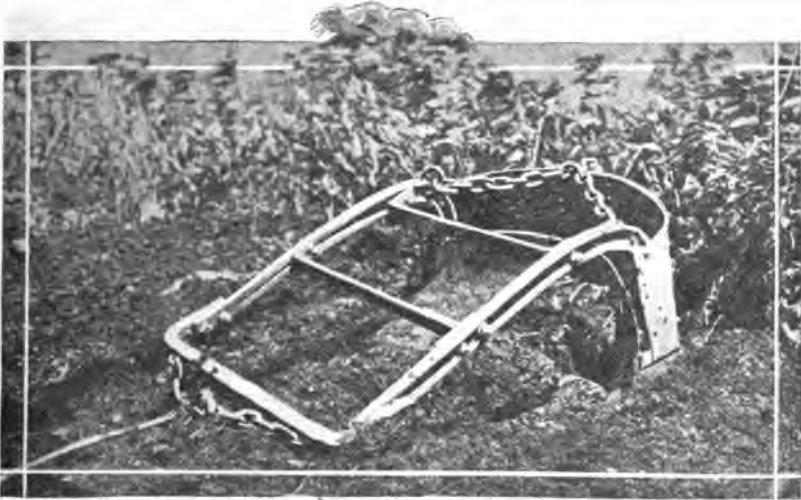


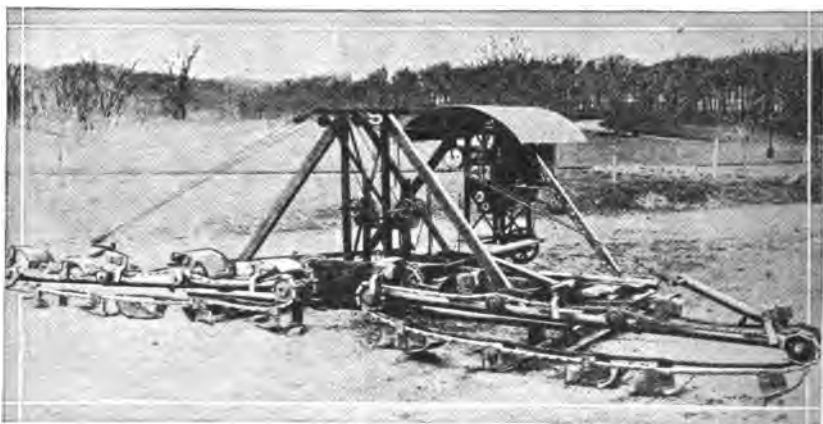
FIG. 18.—Plowscraper used with power-operated backfiller. B.P.R. D-3284

wheels and pulled by horses, may also be used. This machine costs about \$75.

For filling large trenches power-operated back-filling machines are rapidly coming into use. One type is shown in figure 17. This

machine travels along one side of and parallel to the ditch. When all the material at one place has been deposited in the trench the machine moves ahead directly opposite the next section to be filled. The machine can move seven buckets of earth a minute into the trench. It is operated by a 10-horsepower gasoline engine and costs \$2,000.

A unique type of scraper for use with this machine is shown in figure 18. The device closely resembles two plows placed together and secured to a frame with a digging bail. This type of scraper has been used very successfully with the power-driven back filler scraper shown in figure 17. Another back filler which is patterned after the endless-chain and bucket excavator is shown in figure 19. The machine straddles the ditch and the buckets on the endless chains move in toward the trench, each bucket carrying in a small amount



B.P.R. D-3287

FIG. 19.—Endless chain and bucket power-operated backfiller.

of earth. The capacity of the machine, which costs \$5,000, is said to be 100 cubic yards an hour.

COST OF TRENCHING BY MACHINERY

The cost of trenching by machinery depends upon a number of factors, some of which often are overlooked in considering the purchase of such a machine.

The cost of operation per day will depend upon the number of men and teams employed, the wages paid, and the amount and cost of fuel. In respect to labor the internal-combustion engine has the advantage, for usually only one skilled operator is needed, while steam equipment requires also a fireman and a team with driver to haul fuel and water. It may be that not all of the workmen are paid when work is delayed by unfavorable conditions or for repairs; but

the operator and frequently his helper are employed in making the repairs, and it may often be necessary to pay the men for time lost owing to such causes as rain. Laying tile, blinding,¹ and back filling the trenches of course require further labor, which would be the same for machine work as for hand labor. In farm tile-drain contracts only three items are usually covered—trenching, laying, and blinding.

The amount of work done per day will depend upon the soil conditions, the strength and efficiency of the machine, and the skill of the workmen. One of the most difficult soils to work is a wet, sticky clay; a sandy subsoil often will cause difficulty. The presence of large stones or thick tree roots will of course interfere greatly, more so than with hand ditching. Very hard subsoil may make progress slow. Some of the machines have worked through 15 inches of frost, but this is severe work for any trenching machine or excavator, as it subjects the machine to strains which it was not planned to withstand. Some clays become baked hard enough in dry periods to make trenching slow. These various conditions will show the weak points of a machine, and may cause a considerable variation in the cost of operation, due to the cost of new parts and repair work and the resultant loss of time.

It may be of interest to note a few instances of work by machines. In a saturated loam soil a machine of type F dug 105 rods of trench, 14½ inches wide and 40 inches deep, in 9 hours (an unusually good day's run). In a heavy, sticky clay, another machine of the same type dug 280 rods of 12-inch trench, 3½ to 5½ feet deep, at the rate of 61 rods in 10 hours, the best day's work being 91 rods.

The matter of lost time is of great importance, for the owner usually is losing money when his machine is not digging. The portion of a year during which a machine does not work is surprisingly great, even to many drainage contractors, and will explain why trenching with a machine costs so much more than one ordinarily would expect even after watching the machine work for several days under adverse conditions. While a machine is on the work there is loss due to stormy weather, and sometimes due to flooding of lowlands; there are delays for repairs, including waits for new machine parts; and there is time spent in moving from one trench to another. Interest and depreciation charges accrue during all these delays, as well as on Sundays and while the machine is being transported between jobs or lies idle waiting for new work. In the Northern States there are two to four months of the year when frozen ground and cold weather prevent work of this kind, except at rates too high for farm drainage. A contractor who has his machine actually digging 200 days in the year is fortunate.

¹ "Blinding" is carefully placing the first few inches of earth around and over the tile to hold it in position and protect it while the trench is being filled.

It will be helpful to examine the record of one large contract on which the conditions were fairly good. The machine of type F arrived June 24 and began digging July 3; trenching was completed October 1. Of the 100 days the machine was on the job there were 14 Sundays, 61 days of machine work, and 25 days lost on account of repairs, rain, and miscellaneous delays. The main drain, of 5-inch to 12-inch tile, was 358 rods long and about 3.9 feet average depth. The lateral drains, of 4-inch and 5-inch tile, had a total length of 6,055 rods and an average depth of about 2½ feet. Of the 61 days of work, 12 were required for the main drain and 49 for the laterals. The average rates of progress, considering only the days of actual work, were 29.8 rods per day for the main drain and 123.6 rods per day for the laterals. If the 25 lost days be included, the working days actually used were 15 and 71 for the main and the laterals, respectively, and the average rates of digging are then computed as 23.9 and 85.3 rods per day. Coal was used as fuel, 24 short tons being required to dig 6,413 rods of ditch, or an average of 7½ pounds per rod of ditch. Repairs amounted about 15 per cent of the cost of operation.

Another large machine¹ of type F dug from August 3 to December 7, 1918, 3,331 rods of trench in 636½ operating hours, an average of 5.2 rods per hour. The machine was operated 10 hours a day for 6 week days. The time lost due to repairs was 221½ hours; 9½ hours were lost on account of weather and 67 hours on account of moving between jobs on 40 different farms. The depth of trench varies as follows: 3,073.5 rods, 3 feet deep; 74 rods, 3½ feet deep; 130.5 rods, 4 feet deep; 36.5 rods, 4½ feet deep; and 18 rods, 5 feet deep. Some of the soil was quite stony. The amount spent for repairs was \$241.27. The amount of gasoline used was 1,540 gallons, or an average of 1 gallon for 2.16 rods of trench dug. The gasoline cost \$415.53; oil and grease cost \$79.59. The machine crew consisted of one operator and one helper.

The average digging hours per 10-hour day of 15 State-owned machines operating in New York¹ during 1918 was only 4 hours, the remainder of the time being spent on repairs, delays on account of rock, and frequent moving between farms.

For tile trenching and laying by hand, where experienced men are employed, the rate of progress for one bottom man and one top man for the smaller sizes of tile laid not more than 3 feet deep is ordinarily 15 to 25 rods per day, depending largely upon soil conditions. In some sections of the country, where the use of unskilled colored labor is necessary, the same number of men will put in, even with good supervision, only 5 to 8 rods per day per man; the cost for this labor per man is, of course, considerably less than for the other.

¹ Data collected by J. R. Haswell, senior drainage engineer, Bureau of Public Roads.

It should be stated that there is not a great difference in the cost of trenching, as between handwork and machine work. The advantages of the latter method lie in the shorter time required to install drains and in the less difficulty in securing the few workmen wanted. Men capable of satisfactorily operating a trenching machine can usually be found, even where it is impossible to secure workmen to do acceptable hand trenching without close and constant supervision. On the other hand, a farmer buying an expensive machine to do a small amount of work might experience some difficulty in keeping it busy with profit until it can be sold.

SELECTING A TRENCHING MACHINE

In selecting a trenching machine the prospective purchaser should consider carefully the amount of work to be done by it, the dimensions of the trenches to be dug, the nature of the soil to be excavated, and other conditions of work.

The wheel type of excavator is most generally used for installing farm drains, probably owing to a lower cost for the smaller sizes of this type than for the chain type. Machines of the latter kind have greater range in size of trench than do wheel excavators of the same weight, and seem to be better adapted for work where there is a great deal of tile 10 inches and larger. When the greater portion of a job is small tile at ordinary depths, that trenching machine should be selected which will handle best the bulk of the work. Ordinarily it is not advisable to buy a large machine when only a few hundred feet of large tile are to be laid or a small amount of deep trench is to be cut.

The weight of the excavator is important in digging soft earth, and may require the use of apron tractors instead of the less expensive wheels. Sometimes internal-combustion engines are preferred to steam equipment because they weigh less. Internal-combustion engines are also quite popular for the smaller machines because the number of men required for operation is less, but they are not so dependable for continuous operation as are steam engines. In some localities, gasoline and similar fuels are not easily obtainable, and if wood is plenty and cheap this may make steam machinery more desirable.

A trenching machine should be constructed of good materials and be well proportioned for strength. Simplicity of construction is desirable. The great loss of time on a job due to faulty operation of internal-combustion engines, and to delays for repairing broken chains, bolts, gears, and other pieces, requires the elimination of as many parts as practicable. The cost of repairs depends a great

deal upon the skill and care of the operator. Comparatively little time is consumed in moving from one drain to another on the same tract.

In selecting any type of machine the prospective purchaser should ascertain whether the manufacturer will be able to furnish repair parts on short notice, as delays in obtaining repairs will invariably increase the cost of operation and oftentimes materially lengthen the time of operating.

While it is manifestly impracticable to make a hard-and-fast rule which the landowner may apply in selecting a trenching machine for his particular needs, the following general statements may be of assistance:

If a landowner expects to install 100 rods of tile drain in soil which would require picking, but which contains no rock, he would be justified in buying a ditching plow costing as much as \$20. If he proposes to construct 1,500 rods of tile drain in soil free from rock and large roots, the landowner can well afford to purchase a horse-drawn ditching plow costing from \$300 to \$500; and if it be assumed that the owner can sell his machine, when his ditching is completed, for \$200, he would be justified in purchasing such a machine for the construction of 1,000 rods of drain. For the installation of as much as 5,000 rods of drain in a soil free from rock, stumps and large roots, the purchase of a power-driven trenching machine costing as much as \$3,000 probably would be justified, on the assumption that the machine could subsequently be sold for one-half its original cost. Very economical results may be obtained where several landowners unite in the purchase of such a trenching machine as is most suitable for their combined work. The machine should preferably be run by the same operator for all the work.

Machines costing over \$5,000 are suitable for contractors, owners of large plantations, and others having an unusual amount of trenching to do.

CONCLUSIONS

In comparing the real costs of different machines and implements one must consider not only the purchase price and the operating cost for fuel, oil, and labor, but also repairs, interest on the investment, and depreciation. The interest on \$20 invested in a plow is not large; repairs will cost little, and the implement will last many years. For a \$3,000 excavator the interest charge would be \$180 per year at 6 per cent, depreciation might be \$450 or more per year, and repairs would be considerable. Operating expenses and repair costs depend largely upon the amount of work done, but interest and depreciation continue whether the machine is in operation or stands idle. Therefore the owner of an expensive machine must

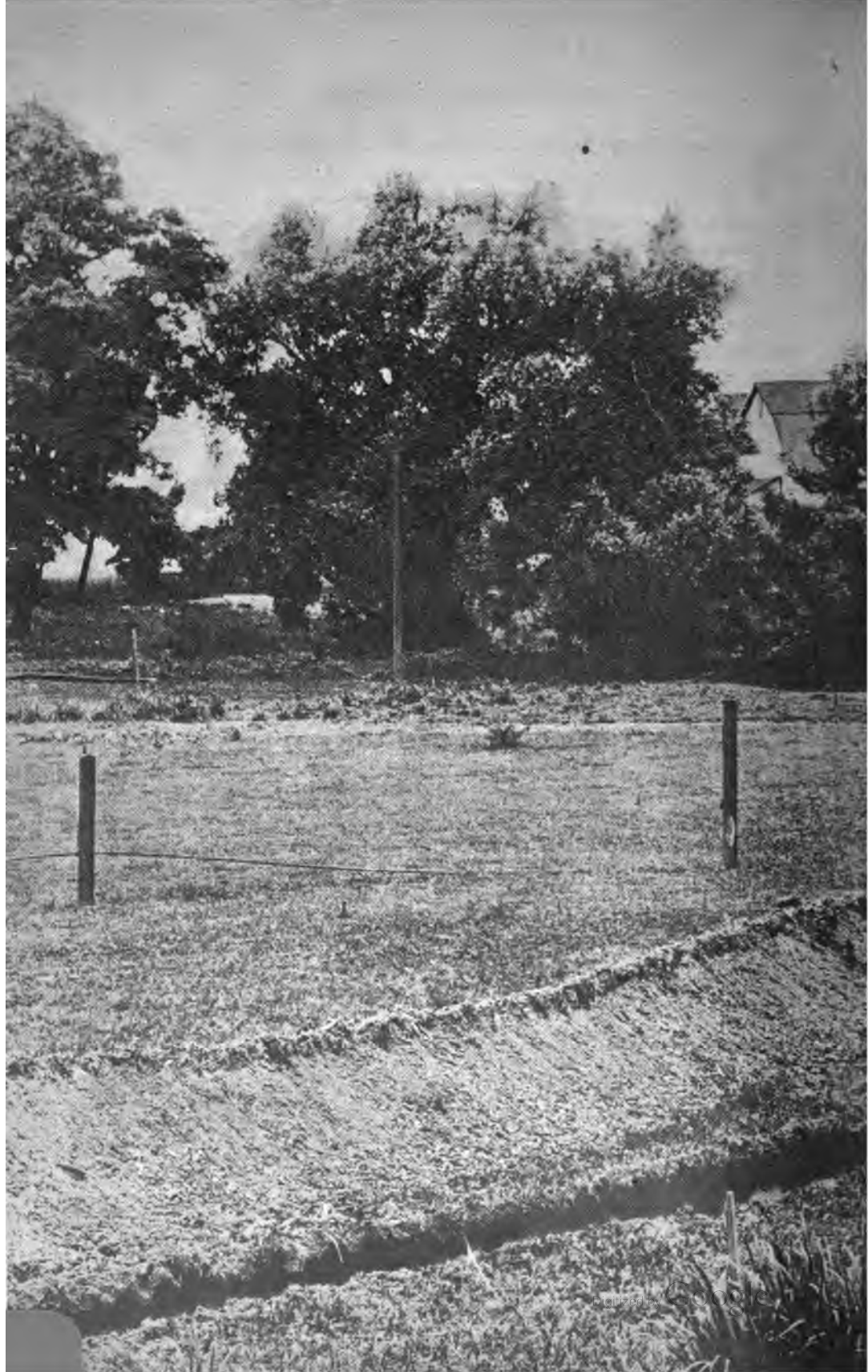
keep it busy a large part of the time if his investment is to be profitable.

On large jobs costly excavators may profitably be employed, but an inexpensive tool may be most economical for work that can well be done a little at a time when men and teams regularly employed on the farm might otherwise be idle. One of the greatest advantages of the large machines, from the farmer's viewpoint, is that the work is done rapidly; from the contractor's viewpoint there is often great advantage in using only a few men, as the employment of large numbers often involves labor difficulties.

Work is slow and costly in caving soil, in quicksand, and in sticky gumbo. Large stones, stumps, and roots cause annoyance and delay, and if in large quantity may make hand spading the cheapest method of excavation.

The data on capacities given on the preceding pages must be used with extreme caution, principally because the kind and condition of the soil and the skill of the operator affect the cost so greatly. The quality of the work also depends upon the carefulness and experience of the operator. Each purchaser must consider the limits of the work he will have to do and the conditions to be encountered, then determine what machine will best meet the requirements as a whole.

The names and addresses of the manufacturers of the various machines discussed in this bulletin will be furnished on application to the Bureau of Public Roads, Department of Agriculture, Washington, D. C.



FARMERS' BULLETIN 1132
UNITED STATES DEPARTMENT OF AGRICULTURE

PLANNING *the* FARMSTEAD



THE OBJECT of this bulletin is to set forth general principles involved in planning the arrangement of the buildings of the farmstead in their relation to one another. These principles of good planning are illustrated by application to a farmstead of a type common to the Middle West. It is not possible to treat all types of farms or all of the number of varying conditions that influence the solution of individual problems, but the bulletin will assist the farmer in applying general principles to his own farm. The main considerations influencing the determination of the farmstead site are its location with respect to the rest of the farm and to public utilities, the elevation and drainage of the proposed site, the available water supply, the nature of the soil, the relation to the points of the compass, the prevailing breezes and protection from heat and cold. After the site has been selected, the type of farming practiced, together with efficient routing of routine work, have an important bearing on the arrangement of the various buildings. It is advisable, in order to secure the best results in locating and arranging the farmstead, to study the plan on paper. This procedure assists in the visualization of the whole scheme and the completed plan, representing the ultimate desire of the farmer in regard to his layout, gives him and his family a goal to strive for if he is unable to carry out the full plan at once, and so must adopt the policy of doing a little at a time.

Contribution from the Bureau of Public Roads

THOS. H. MacDONALD, Chief

Washington, D. C.

August, 1920

PLANNING THE FARMSTEAD.

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Division of Rural Engineering, Bureau of Public Roads.

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FARMING is a business, just as is the manufacture of automobiles or any other industrial activity. The successful farmer must be a good manager, and the better his management the greater his success. While a good manager may accomplish much with poor equipment, he can do much more if his plant and equipment are properly designed and arranged.

Under existing economic conditions, namely, the increasing price of land, equipment, machinery, etc., and the scarcity and high price of labor, it is necessary to increase the output while maintaining the same unit cost of production, or to lower the cost of production, in order to secure an adequate return upon capital invested in farms under normal conditions of supply and demand. If a lowering of cost and increased production can be secured at the same time, so much the better.

In most manufacturing lines, and in agriculture as well, quality is as productive of return as is quantity; an improvement in working conditions which permits an increase in the volume of work accomplished may perhaps be utilized to secure an improvement in quality of product, since under the same conditions it is possible to put more time on any given piece of work.

The farmer who desires to obtain the greatest possible results from his operations, whether he be already established or just entering upon his venture, may profit by the example of some of our successful industrial establishments, where, in order to reduce cost of pro-

duction or to increase the output, whole plants have been remodeled or entirely new plants erected, all carefully arranged and equipped to meet the particular requirements of the work to be done.

Very few established farmers are in a position to tear down all their old structures, and to build entirely anew, or to move to a new location, but a great many farms can be improved by moving or remodeling some of the buildings in order to save the time and energy of the workmen in the performance of routine work. There are other considerations which enter into the problem of increasing farm production, such as the installation of proper machinery, the development of natural power resources, where available, in order to save man and animal power, and the use of the best methods of crop growing and marketing; but these are aside from the question of planning the farmstead.

Certain well-founded principles are involved in the planning of an industrial establishment, which apply as well to the laying out of a farm plant, and there are others which are peculiar to the farm problem. It is the purpose of this bulletin to explain the principles affecting the farm layout by applying them to given problems. It is not possible to develop a plan having general application, because the conditions to be met in each case vary, though the principles to be observed remain the same. The location of the farm with reference to highways and town, the topography of the land, the climatic and soil conditions, and the type of farming to be undertaken all have their influence on the location of the farmstead and the arrangement and design of the buildings.

THE FARMSTEAD.

The planning of a farmstead layout involves the arrangement of the various buildings, yards, lots, etc., with relation each to the other, to the fields and to the highway, in such manner that there shall be a minimum of time consumed, no retracing of steps, and no lost motion in executing the routine work of the farm. It includes the designing of each building or other unit for the particular purpose for which it is intended, and its location with reference to its functional relation to other units. It means the creation of a practical business establishment in combination with a home which must be attractive and inspiring to its occupants if the best is to be had out of farm life.

It is not within the scope of this bulletin to take up the details of the designing of the various farm buildings, but it may be said that in planning the structures of the business or producing part of the establishment consideration must be given to the question of return on the investment. Pleasing architectural effects, tempered with

economy in materials and construction, should be sought in the designing of the buildings, such as barns, stables, and the smaller structures, but the first consideration is that of utility.

The farmhouse is another problem. Here utility, while of prime importance, is not or should not be the only determining factor. The amount of money invested in a house should be such that the net income of the farm can easily take care of the interest, if interest must be paid, without too great restriction upon other expenses. Within this limit, the farm home should have all the conveniences and comforts possible, and should be as attractive in design and surroundings as it can be made.

Where ample capital is available, all permanent buildings and equipment as a sound business proposition should be of the best materials and of substantial construction. The farmhouse, however, should be more than well built; it should provide ample accommodations for those it is to shelter; it should be well lighted and warm; it should have all the conveniences and labor-saving devices possible in order that the housework be reduced to a minimum, and it should be furnished in good taste. The cost should not be viewed as a financial investment upon which the farm business must pay full interest. Money judiciously expended on the farm home earns a return that is not to be measured in cash. A sense of pride in the ownership of an attractive abode; the physical well-being of those enjoying a healthy, wholesome, and happy family life; the effect of pleasing surroundings which, though rather intangible, is reflected in the contentment and loyalty of those concerned in the maintenance of the home, constitute a return which, while indeterminate, has a monetary value. A pleasant farm home life affects the business of the farm in many ways, all tending to increase returns on the business investment.

Careful arrangement of the farmstead and intelligent planning of the farm buildings is good business under any circumstances, but it is especially important when capital is limited and must be made to go a long way. When such is the case the farm business plant must be first considered, but the ultimate farm home should be planned for with the rest of the farmstead. Possessed of the plans for an attractive home, the farm family has something toward which to work, an incentive to thrift and economy in the operation of the farm, and a tie to farm and home life not easily broken.

PLANNING THE FARMSTEAD.

SELECTING THE SITE.

The established farmer who contemplates improving the working facilities of his farm must take conditions as they are, and remodel, tear down, or move, as may be necessary or advisable. When unim-

proved land is to be developed, the purchaser usually gives consideration to its suitability to the business he intends to pursue, the character of the soil, the lay of the land, the accessibility of markets for his products, etc., but a very vital consideration is frequently overlooked, namely, a suitable location for the farmstead.

Much of the success of the farmstead plan depends upon the care expended upon selecting the location. This is not always a simple matter, because the features that influence a choice of location are numerous and often conflicting. Of the more important considerations there may be mentioned location with respect to the rest of the farm and to public utilities, elevation and drainage, water supply, nature of soil, orientation, prevailing breezes, and protection from heat and cold.

LOCATION WITH RESPECT TO REST OF FARM AND TO PUBLIC UTILITIES.

In determining the location of the farmstead, careful consideration should be given to the arrangement of the fields. This is influenced by the topography of the land, drainage, soil conditions, location of natural pasturage, cropping scheme, etc. Ease of access to the fields from the buildings is highly desirable, as otherwise loss of time due to inconvenience will be incurred. This consideration has, of course, less significance on the small than on the large farm where the buildings must be somewhat centralized in order to insure economy of operation.

Figure 1 is suggestive of a layout in which the distance from the buildings to the fields has been reduced practically to a minimum. Such a scheme is economical (1) in time consumed traveling to and from fields with implements or in driving stock; (2) in supplying the fields with water for the animals (from a central supply); (3) in fencing, as no long lanes are necessary. As a general thing long lanes and the consequent additional fencing constitute an economic loss. If direct access to the farmstead from two or more fields is desired, other conditions permitting, the farmstead may be moved east or west to the corner of field E. This gives direct access to four fields, with no increase in the amount of fencing or pipe lines, and also avoids dividing field E by the approach from the highway.

A farmstead so located does not possess certain advantages arising from a closer relation to the highway. Traffic is a source of considerable interest to the average farm family. The ability to observe at close range or to hail those passing on the road tends to promote social intercourse and participation in community affairs. A layout such as shown in figure 1 is particularly applicable to the farm north of a highway, since a dwelling on a farmstead close to that side of the road is subjected to the dust blown by southern winds. A farm-

stead situated a considerable distance from the road is not subject to this nuisance.

The advantages obtained in locating a farmstead at sectional cross-roads often justify the selection of such a site. In figure 2 a cross-roads site is shown. Town, railroad, school, church, etc., may all be so located that this corner of the farm is nearest to them. If more important considerations do not conflict, this condition might well warrant such an arrangement, since there would be a considera-

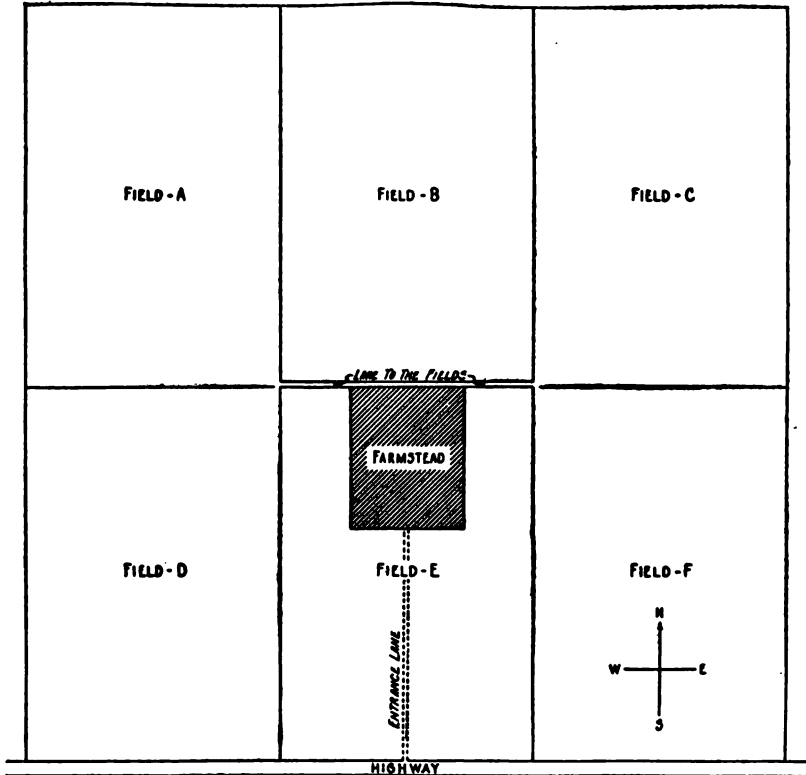


FIG. 1.—Economical relation of farmstead to fields.

ble saving of time in traveling to and from the farm. Quick access to both highways is advantageous. Live stock and farm traffic can be handled through the rear entrance, thus leaving the dwelling and grounds free of the farm business. Frequently the back lane is a short cut to the destination.

The relationship of farmstead to farm is often influenced by farm practice. Figure 3 shows a layout which provides for a minor pasture rotation for hogs, in addition to the rotation of general farm crops. A 3-field rotation is indicated, and in arranging the buildings on the farmstead, the hoghouse, yards, etc., should be so placed that the hogs may be driven readily to and from the small fields.

ELEVATION AND DRAINAGE.

The wise purchaser selects land suited to his purpose, but generally having a moderate elevation with a slope to the south and east, neither so high as to be difficult of access, nor so low as to be damp, subject to frost, poor drainage, and lack of air circulation. This is essential to the production of the best crops, but it is of

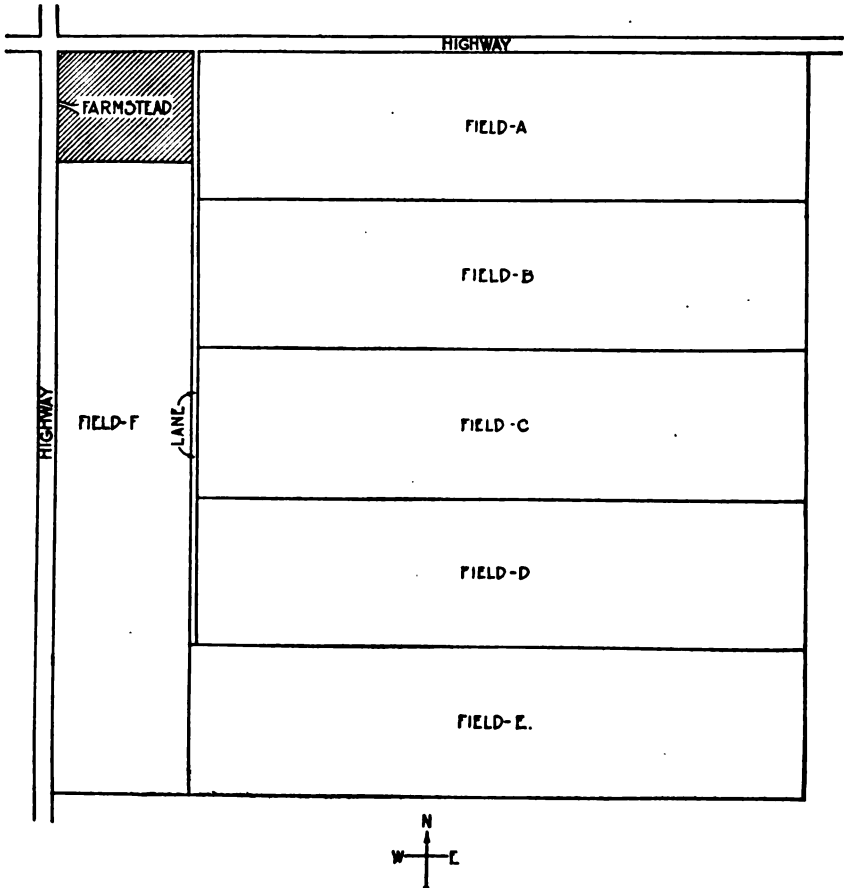


FIG. 2.—Location of farm at cross roads.

greater moment with respect to the good health of the family, than which there is no more valuable asset on the farm.

It is of great importance that the farmstead site have a slope, in one or more directions, sufficient to carry off all surface water from about the buildings and yards. Good drainage about the farmstead insures dry floors and comparatively dry paths and driveways, making it easier to get around in bad weather. For this reason a knoll or hillside with moderate slope should be sought. Frequently an otherwise desirable site may not have perfect drainage, in which

case a little filling, ditching, or tiling may correct the fault. The ground around a well or about the stock yards may need some such treatment. Much of the sickness on farms may be attributed to the seepage of foul water into the wells, a condition which, in many instances, may be corrected by proper grading and curbing.

Cattle are more comfortable and no doubt put on weight more readily in a dry, hard yard than in one which is "knee deep" in mud. The liquid manure from a graded yard may be saved by

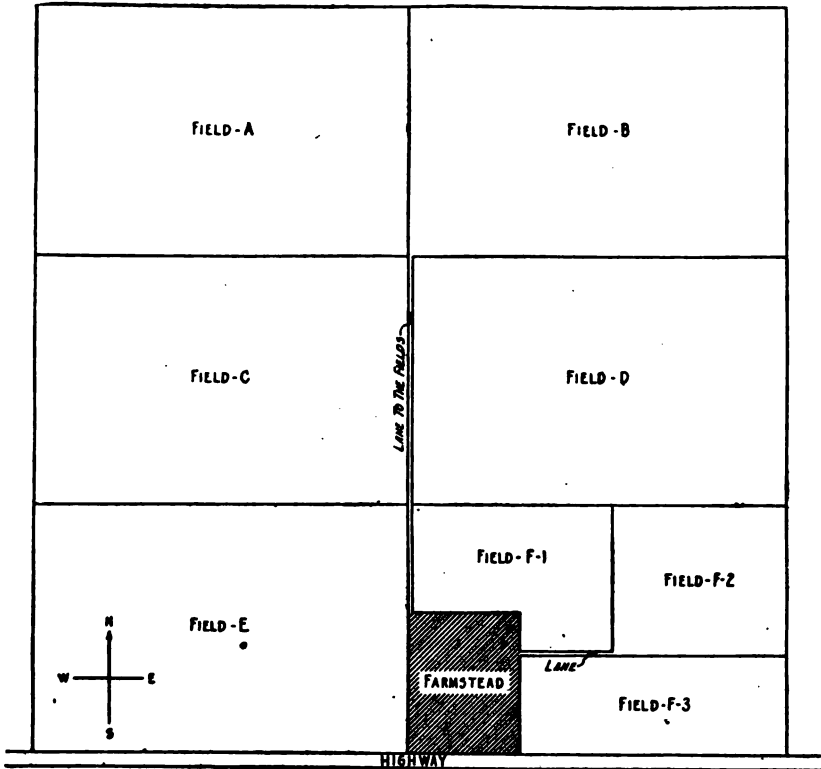


FIG. 3.—Arrangement for a three field hog pasture rotation.

draining the yard to a masonry pit or sump hole. Paving the barn yard with concrete conserves the manure to an extent which should offset the cost of paving in a comparatively short time.

WATER SUPPLY.

Frequently the buildings and yards may be so located that water from a spring, well, or infiltration gallery can be delivered by gravity, and such a system is ideal. Other things being favorable, it may be well to locate the farmstead so as to take advantage of

this, but water may be pumped with comparatively little expense from any reasonably distant source, and the advantages afforded by another location with respect to drainage and the arrangement of buildings, yards, etc., may be of greater value than that of a gravity water supply.

NATURE OF SOIL.

The garden, lawn, orchard, and windbreak, constituting a considerable portion of the farmstead, require good and preferably light soil, while the ground occupied by the farm buildings may be the poorest land on the farm. Not infrequently the two kinds of soil may be found within the farmstead area, but it is better to sacrifice a little crop-producing land for the buildings than to handicap the garden or orchard with poor soil. Sandy or gravelly soils are excellent for general farmstead purposes, as they are favorable for plant growth and drain rapidly—very desirable qualities. While good soil within the farmstead should be sought, still, because of its crop-producing value, it should not be wasted in yards, lots, and lanes; in other words, the farmstead should be made as small and compact as possible without affecting the efficiency or attractiveness of the layout.

ORIENTATION.

The points of the compass have an important bearing on the proper arrangement of the buildings on the farmstead, and it is well to keep this in mind when purchasing farm land or in selecting a site for and planning the farm buildings. Sunlight is one of the most potent enemies of dirt and disease. Germs do not thrive in sunlight, and dirt is more readily detected in a bright, cheery room than in one that is dark and dreary. It is very desirable, therefore, that all shelters of human and animal life receive the utmost benefit of the sun's rays during the winter and of the cooling breezes in the summer time. The principle of orientation is the arranging of the various parts of a building so that this end may be attained.

The average home builder wants his home to face the road, meaning that the principal rooms and the main entrance, not necessarily the entrance most used, look out upon and are in evidence from the highway. This tendency frequently produces unfortunate results, as in the case of a house situated south of a road running east and west. In this position the principal rooms are toward the north; they lack the cheerfulness imparted by the winter sun, are more difficult to heat in winter, and do not get the benefit of summer breezes.

It often happens, too, that by adhering to this general practice a pleasing landscape picture is lost to view from the living portion of the house. While the existence of an attractive view in a certain

direction does not warrant the sacrificing of important features in the farmhouse plan, yet in order that it may be enjoyed from the front porch or the living room window, the point is worthy of careful consideration. The beauties of nature take hold of the most rugged and practical minds, and have an important part in the attachment which everyone has for his home.

If a farmhouse is situated near the road, it is generally best to place it four square to the highway, but if it is placed fairly well back, there is no reason why it should not be set at almost any angle in order to secure the best results.

The sun's course must also be considered in connection with the planning of the stock shelters and yards. For instance, barns for stock should be placed with their long axes north and south so as to give either side the benefit of the sun for one-half day, and also to allow cooling summer breezes to blow through the buildings.

PREVAILING BREEZES AND PROTECTION FROM HEAT AND COLD.

As a rule, throughout the Middle West, the prevailing summer breezes are from the south, southwest, and west, although in certain localities topographic conditions may cause a variation from this generality. Cold winds and snow sweeping over the farm, unchecked by hills or trees, cause general discomfort to man and beast. Stock in unprotected lots and fields expend a great deal of energy in moving about to find a comfortable spot, and do not gain in weight as rapidly as when protected from cold winds. It requires a great deal more fuel to warm a house that is exposed than one that has a measure of protection.

For this reason, it is desirable to select a site having a south and southeast slope, or one in which existing trees form a natural windbreak, as it requires many years to grow an effective protection. If the locality is without hills or other natural windbreak, a shelter belt of trees should be planted to the north and west of the farmstead. The trees should be selected with reference to nativity, height, denseness and rapidity of growth, ability to resist wind, and commercial value. It is a good plan to plant rapid-growth trees of the less desirable varieties along with permanent planting. In this way, protection is secured quickly, and when the hardier trees have acquired growth, the others may be cut out. The permanent planting should include a goodly proportion of evergreen trees.

Buildings form more efficient windbreaks than do trees and hills and, therefore, should be so placed that they will act as windbreaks to the yards at the same time being open to the sun. Board fences also are valuable in sheltering yards from cold winds.

During the summer months barnyard odors are an annoyance. If the outbuildings are placed to the north or east of the dwelling, the prevailing breezes will carry the odors away from the house. Relief from summer heat is best provided for by permitting the cooling breezes from the south and southwest to sweep unchecked through the farmstead. The dwelling should be so planned that the principal rooms will receive the benefit of these breezes.

A moderate amount of shade should, of course, be provided, especially near the house, since it prevents radiation of heat from the ground, which is perhaps a greater source of discomfort in the house than the direct rays of the sun on roof and walls.

ARRANGING THE BUILDINGS.

TYPE OF FARMING PRACTICED.

Farm practice varies quite considerably in different parts of the country, and even in different parts of the same State, and the number, sizes, and uses of farm buildings vary with conditions as found on farms of different types, such as dairying, beef raising, general farming, fruit growing, etc. Conditions imposed by these variations govern, to a large extent, the arrangement of the farmstead. Careful consideration, therefore, should be given to the variety and scope of the industry likely to be attempted for some time in the future. As far as possible, the buildings should be so arranged and constructed as to provide for additions or changes to conform to increasing business or change of its character.

ROUTING OF ROUTINE WORK.

In laying out a farmstead plan, the route to be traveled in doing the chores should be borne in mind. The buildings should be so placed that in performing the routine work unnecessary walking is avoided. A farmer's time is valuable. Many factory managers have saved large sums of money yearly by merely eliminating a few steps in the daily routine of employees, or by cutting out unnecessary motions in performing a single piece of work. On the farm a great deal of time and unnecessary labor can be saved by carefully planning the various buildings and arranging them in proper relation each to the other.

If the average farmer were told that some time during the year he would find it necessary to take a trip of 150 to 200 miles, and that he would have to walk all the way carrying feed or milk or harness, he would object strenuously and declare that he would not have the time; yet hundreds of farmers are walking every year that much over and above the distance that would be necessary in performing routine work were their buildings efficiently arranged.

THE PLAN ON PAPER.

In order to study the arrangement of a farmstead or the planning of farm buildings to the best advantage, plans should be worked out on paper. When the approximate location of the farmstead has been decided and before any building or fencing is done, there should be prepared two plans—one of the whole farm, at a scale which will admit of ample and easily read legends and notes (100 feet to the inch answers the purpose very well), and one of the farmstead at a much larger scale, possibly 20 feet to the inch.

The first plan or plat should show the location of the farmstead, all roads and lanes, fields, lots, streams, drains (the location of which frequently is forgotten), ditches, fences, permanent natural objects, and all buildings in block form. The fields should be numbered or designated by letters, and the sizes indicated. This will be of assistance in determining the amount of fertilizer and seed needed, in calculating the returns from the crops, in the farm bookkeeping, and in keeping the record of each field, etc.

The plat should be made in ink on tracing linen or thin, tough paper, from which blueprints or, better, whiteprints, can be made. The original should be carefully preserved and the prints used for recording crop rotations, amount of fertilizer and seed used, and any other desirable data. Changes in layout can be made on the original, and a print of the original retained as a record.

The second, or farmstead plan, should be in much greater detail than the general farm plat, and therefore should be drawn at a larger scale. In this plan the several buildings should be shown with the general interior arrangements indicated; all minor accessories, such as watering troughs, feeding racks, scales, fences, gates, hitching rail, all lanes and driveways, walks, trees, shrubbery, etc., should be located upon the plan, each feature being placed with due consideration of its use and its relation to other features, as will be pointed out. It is an excellent scheme to cut out flat pieces of paper representing each structure. They should be made to the same scale as the plan, and should show the general arrangement of the interiors, so that the relations of each to the other may be studied. They may be shifted about into different positions until a satisfactory arrangement has been secured.

The working out of the farmstead plan on paper is of inestimable value to the farmer whose land is unimproved, for the careful study incident to its preparation may save him money and annoyance. The established farmer would do well to prepare plans of his farmstead and buildings and to study them carefully, with a view to remodeling or changing the location of some of his equipment in order to increase the efficiency of his plant.

DESCRIPTION OF FOUR FARMSTEAD PLANS.

It is quite possible that a given farmstead arrangement might be applicable to a number of farms so far as physical conditions are concerned, yet the location of the farm with relation to the highway has a very great influence on the farmstead plan. It is probably the greatest single factor determining the general disposition of the farm buildings. The importance of this factor is shown in the following layouts which represent four farms of like size and character—that is, a general farm of the Middle West—but unlike in their relation to the highway. In these examples it has been assumed that the land is unimproved and that it is practically level and well drained. In the first case, that of the farmstead east of the highway, the buildings have been placed at a crossroads for reasons explained on page 7 and shown in figure 2. In the other three layouts the farmstead is located on the highway in the center of a quarter section. In all of the plans the same buildings are used, except in a few instances when a different type is employed for the same purpose; in such cases reasons have been given. These illustrations are shown as possible solutions, demonstrating and emphasizing the principles which have been set forth.

THE FARMSTEAD EAST OF THE HIGHWAY, FRONTING WEST.

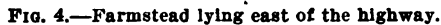
A farmstead located east of the highway lends itself most readily to the application of the general principles explained in the foregoing pages because of the relation between the prevailing winds and the highway. The application of these principles in arranging the buildings on a farmstead so located is illustrated in figure 4. Three views of a model of this layout prepared in the Bureau of Public Roads are shown on the front cover of this bulletin.

The location of the farm dwelling is the key to the whole layout, and therefore should be given first consideration. In this scheme the distance from the highway to the house is about 100 feet, sufficient to permit of an attractive setting and a measure of privacy, at the same time retaining an intimate relation to the highway. The house is readily accessible, and there is no great length of drive to build and keep in repair. The driveway is placed to the north of dwelling in order to avoid the annoyance of dust blowing through the house, to preserve an unbroken lawn on the south or living side, of the dwelling, and to provide a direct road from the highway to the farm buildings, which, because of summer winds, should be placed to the north, northeast, or east of the house.

It is not desirable that the heavier farm traffic pass too close to the house, but in bad weather it is a great convenience for the women folk to be able to step directly from a conveyance to the shelter of the entrance porch; hence a loop in the drive has been provided. It also serves as a turn around for visiting teams or cars.

The house and barn are the focal points of the plan, the smaller buildings, lots, and yards being arranged about them according to their utilitarian relationships.

For reasons previously stated the driveway is placed north of the house, and the main entrance, protected from north winds by a porch, is located on the same side. The kitchen, so planned as to provide ample cross draft, is placed adjacent to the entrance hall, thus enabling the housewife to receive visitors without walking the length of the house, and so that while engaged in kitchen duties she may have the highway, entrance drive, and yard under observation and may readily detect any unusual occurrence.



The barn is about 150 feet northeast from the house and directly on the road from the highway and the fields. The distance and

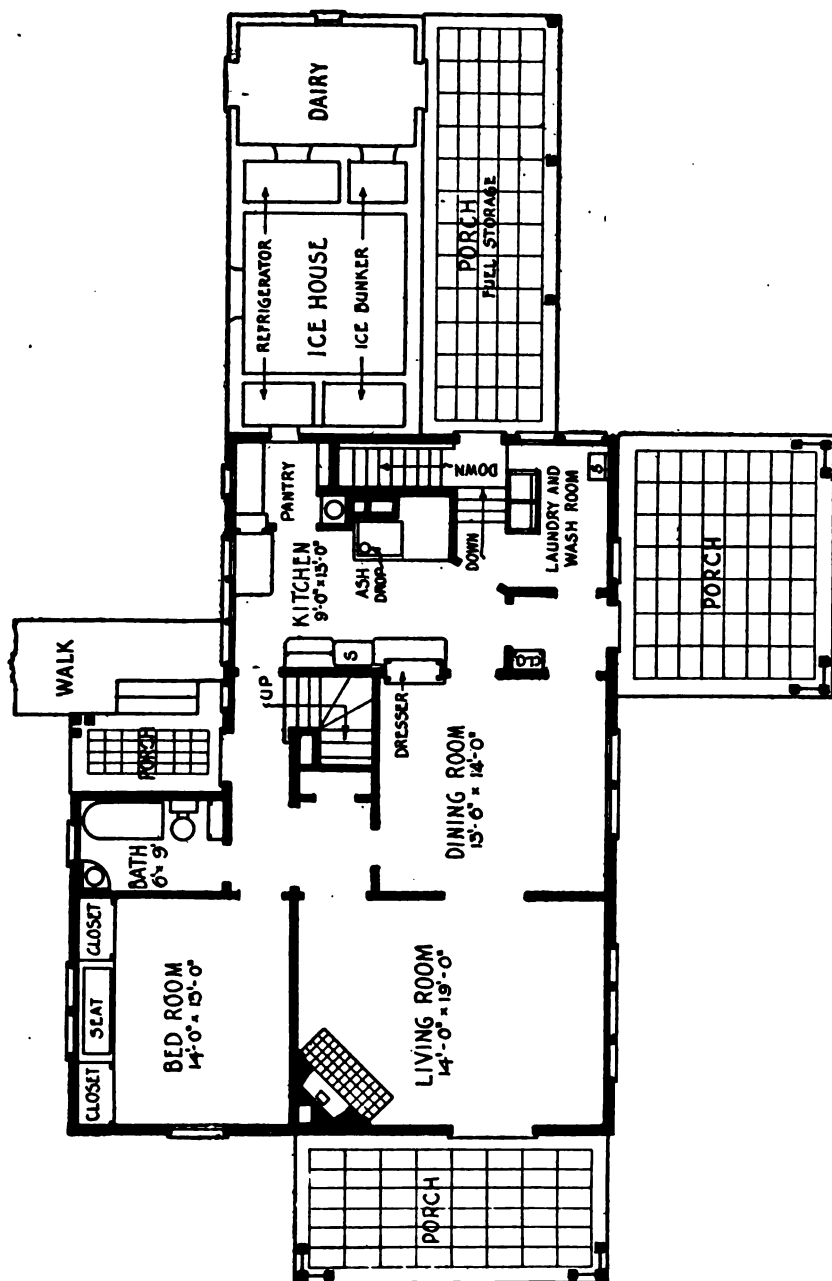


FIG. 5.—First floor plan of house shown in figure 4.

the direction render the dwelling reasonably safe from the annoyances of barnyard odors, and the chances of either building taking fire from the other are small. The type of barn to be used may be influenced by individual preference or particular requirements. Whatever type of barn is decided upon, it should be planned to fit the location. The barn indicated on the plan is of the shed type requiring a well-drained site, as the hay rests upon the ground, the mow extending up to the roof and over the grain bins located at either end. Hay may be mowed away from the north end of the barn, and the grain bins filled from outside. The axis of the barn is north and south, so that all the stock will have the benefit of sunlight during a part of the day. In summer the cool breezes will blow through its length. The horse stable is placed in the northwest corner of the barn, just across the lane from the implement and wagon sheds. This arrangement means a considerable saving of time in getting the teams ready for the day's work. The lane north of the barn and lots is fenced and provided with gates so that it may be used as a horse lot if desired.

Provision for a few milk cows is made in the southwest corner of the barn, near the cow pasture, which is reached through the cow lot. This leaves the east side for cattle. They get the full benefit of the morning sun, are protected from the cold winds, and are in close proximity to pasture, fields, and back lane, which are so arranged that the stock may be handled easily and quickly. By shifting the fences the lots may be arranged to suit other methods of stock management.

The location of the silo is convenient for either barn or yard feeding of the stock and is not far from the cow stable. It is placed far enough from the barn to permit filling a wagon from the chute. When the silo is being filled the engine and cutter may be placed so that teams coming from the fields can pull directly through the hog lot and stop in proper position alongside the cutter.

A manure shed is situated opposite the alley back of the horses and cows. It is a short carry from the barn with barrow or litter carrier and a short haul from the stored manure to the garden or fields. If it is desirable to haul the manure to the fields daily, the shed should be planned to shelter a spreader in such manner that the manure could be placed either in the spreader or in the pit, should bad weather prevent daily spreading.

To the east of the barn is a double corncrib and granary, providing for a reserve supply for the barn bins and a direct supply for yard feeding.

The hog lot adjoins the cattle yard, facilitating the common practice of allowing the hogs to follow the cattle. A hog house with two rows of pens is placed with its long axis north and south, so that each side will have sunlight during the day. In addition to the inside pens, there may be provided sun pens for outdoor exercise. A concrete feeding floor is shown between the crib and the hog house. Corn may be thrown from the crib directly onto the floor, which is protected by the two buildings and by a tight board fence on the north.

Platform scales are located in the lane, so that a wagon may be driven over the platform without going far out of the regular line of travel, and that cattle may be weighed readily.

The uses of the implement shed, wagon shelter; and shop are so closely related that they have been combined in a group and placed directly on the line of travel past the barn and close to the entrance to the horse stable. The wagon shelter is open on both sides, so that teams coming from the highway or fields may be driven under cover, unhitched, and taken directly to the barn, thus eliminating the backing of heavy equipment in daily use. As the implement shed is connected with the shop, all machinery put by in the shed may be overhauled and repaired under cover. A large piece of work can be run into the shop if necessary. The shop is of two stories, the upper floor being intended for use as an office, bedroom for extra hands, or seed corn storage. In case it is desired to use this room for corn, precautions should be taken to prevent rats and mice from climbing up walls by placing fire stops between the studs and by the use of galvanized-iron strips.

Just off the line of travel and convenient to the shop is a garage with doors at both ends, so that it may be entered from either direction, the necessity of backing being avoided.

Poultry should not be allowed to run at large over the farmstead. It is undesirable from the standpoints of good business and of sanitation. A henhouse, at the best, is none too clean and should not be placed near the dwelling. At the same time it should be convenient in case the women folk should be called upon to care for the poultry. Care should be taken that there is no danger of surface drainage from the chicken run contaminating the water supply. The orchard fence should be hog tight, and it costs but little more to make the inclosure hen tight, thus providing an excellent poultry run. To the east of the orchard is a small plot reserved as an emergency stock lot and for future buildings. With the house placed as in this plan, between the orchard and the reserve field, poultry in sufficient number for a farm of this kind will have ample room and a change of run. The small field also may be used for root crops.

The truck garden lies between the house and the barn. In this location it is convenient for the housewife when in need of fresh vegetables.

Sources of water supply vary on different farms and there are several methods of delivering water to the buildings and lots. A safe, dependable supply is of highest importance and the subject is fully covered and illustrated in Farmers' Bulletin No. 941, "Water Systems for Farm Homes," which may be obtained free from the Division of Publications, Department of Agriculture, Washington, D. C. In the plans illustrated in this bulletin it is assumed that the water is taken from a well and that a power pump is necessary or desirable. In this particular layout a well house sheltering the pump is placed just back of the dwelling, near enough for convenience in caring for the machinery yet not so close that the sound of the pump or engine would be annoying. The wellhouse also serves as a convenient place to keep garden tools.

Drinking water is provided for the stock at three points outside of the buildings—one just outside of the wellhouse, where teams may

be watered without going to the barn; one at the end of the implement shed, accessible from the yard, the lane, and the reserve field north of the lane, and one to serve the stock in the cattle lot, the hog lot, and the pasture.

Sewage drains to a sewage or septic tank located in the pasture near the fence and thence is distributed in shallow-laid drain tile through the disposal field. Further information on the subject is contained in Yearbook Separate No. 712, "Sewage Disposal on the Farm," which may be obtained from the Division of Publications, U. S. Department of Agriculture.

However closely a farm layout may approximate the ideal from the standpoint of efficiency and practical economy, it lacks completion unless it provides for the beautifying of the grounds with trees, shrubs, vines, and flowers.¹ A little planting judiciously placed will give to the most unpretentious abode that aspect of inviting restfulness which is essential to a real home. It will add to the selling price, or at least it will increase the chances of a profitable sale, for many properties have been sold to advantage on the strength of attractive appearance, even though lacking in other respects.

In laying out the driveways straight lines have been avoided. Graceful curves in walks and drives and informal plantings about the house are in better keeping with the life of the average farm home than are the effects produced by straight lines and plantings set out in geometrical patterns. The practical and esthetic often may be combined in some portions of the planting scheme. The trees about the house are intended to be both ornamental and useful. They frame the views from the house and provide attractive views of the buildings from the road. The shading of the lawn makes the house more comfortable in the summer and adds greatly to the pleasure of leisure hours.

An orchard is primarily a practical adjunct of the farmstead, but a well-kept orchard, especially when in full bloom, is a most pleasing sight. In this plan the orchard has been placed near the house, where it is sheltered by the windbreak.

In the plot between the house and the barn are fruit trees, berries, etc., sufficient to supply the household needs. In the barnyards are a few trees which will need protection from the stock, but the stock will be benefited by their shade.

If the selected site is lacking in mature foliage a few trees of rapid growth may be planted and cut out when more desirable varieties of slower growth have attained sufficient size.

THE FARMSTEAD WEST OF THE HIGHWAY, FRONTING EAST.

The arrangement of the farmstead west of the highway is more difficult on account of the desirability of providing south yards for stock. While this is not absolutely necessary in all cases, it is very desirable because buildings form the most effective windbreaks. In locations where it is necessary to await the growing of trees, shelter provided by the proper placing of the buildings is essential. A sug-

¹ The planting schemes indicated on the four layouts illustrated were planned by F. L. Mulford, Horticultural Investigations, Bureau of Plant Industry.

gested arrangement of a farmstead in this location is shown in figure 6.

The dwelling is the same as in the preceding layout and is in the same relative location, except that it is reversed from east to west, placing the living rooms toward the highway, and the kitchen, wash-room, and icehouse and dairy toward the barn. The drive is in the same comparative location as before. The barn is directly north of the house, thus avoiding obnoxious odors in the dwelling, and is far enough away to allow a reasonably large barnyard, protected from the north and west, without being too much in evidence from the house. The yard is separated from the road by a small pasture,

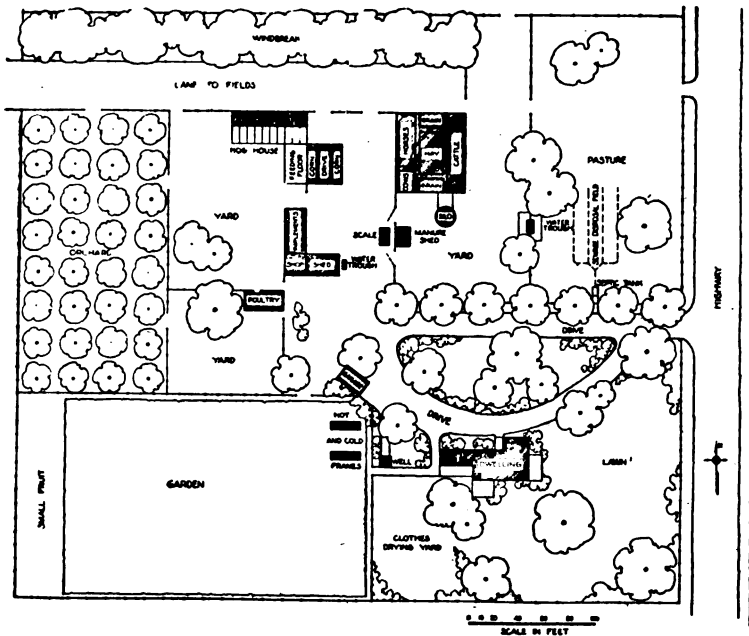


FIG. 6.—Farmstead lying west of the highway.

which can be used as a back lane to the highway in such instances as when stock is being driven to market, making it unnecessary to turn them loose over the drive and lawn.

The yard is screened from the house by shrubbery and trees. The location of the stock in the barn with regard to the points of the compass is the same as before, the cattle in the east side, the cows in the southwest portion and the horses in the northwest. The combined implement shed, wagon shelter, and shop is convenient to the horses and to the garage directly to the south.

The double corn crib is placed adjacent to the hog-feeding floor and is convenient to the barn. It is located so that a team can be driven through it, thus facilitating yard feeding of the cattle.

The hog house and yard, west of the barn, are so situated that the hogs may be turned into the orchard when desirable. In this plan a single-row house has been substituted for the double-row house used in the preceding example, because its entrance is more convenient

to the barn and the building, being longer, affords better protection to the yard. The single-row house is not as economical as the double-row house because of the greater alley space, but in this case its use seems advantageous. The hog yard does not adjoin the cattle yard, but they are connected by a lane, making it possible conveniently to transfer the hogs to the cattle feed lot. The location of the scales south of the barn and in a line with the fence, permits the use of double gates, which adds to the convenience of weighing cattle and makes the scales readily accessible for almost any purpose, particularly the weighing of produce hauled away from the farm or the checking of weights of supplies. Its location is not ideal for the weighing of corn from the field before storing in the corn crib, as it involves turning around and driving back a short distance, but the weighing of corn from the field is only one of the many uses for the farm scales and it is hardly possible to attain, in any one scheme, an arrangement which is ideal in every respect. Good planning lies in the weighing of the various advantages and disadvantages and the selection of those best suited to the purpose.

The poultry house and yard, situated south of the hogs, is convenient to the dwelling. The yard adjoins the orchard, making it possible to secure additional run.

The well house is between the dwelling and garden. Watering troughs are provided at two points outside the buildings; one at the end of the open shed and one between the cattle yard and pasture.

The septic tank and a sewage-disposal field are located north of the drive in the pasture.

A windbreak is indicated along the north side of the farmstead. The orchard on the west affords protection from west winds and is itself protected by the windbreak on the north.

THE FARMSTEAD NORTH OF THE HIGHWAY, FRONTING SOUTH.

The solution of the farmstead layout north of the highway, shown in figure 7, is similar in general arrangement of the buildings to the one west of the highway. The dwelling shown on this plan is the same as the preceding layout, but the plan has been turned, with the long axis north and south, in order that the entrance may be accessible from the drive, and that the kitchen, wash room, ice house, and dairy will be in proper relation to the outbuildings. This shows the effect of location on the house plan. The interior of the house would have to be redesigned in order to obtain desirable exposure for the principal living rooms.

The prevailing breezes from the south and west would tend to blow dust from the highway into the house. For this reason it is set back further from the road than in the other farmstead layouts, the distance in this case being about 160 feet. In some instances it might be advisable to place the house still further from the road, especially on unprotected sites.

The driveway, with a loop turn-around, is laid out to the east of the house in order to minimize the nuisance of dust from that source. An unbroken expanse of lawn to the south and west of the house permits the development of an attractive outlook from the living rooms.

posure of yards has been indicated in order to show that they may be secured, no matter in what direction the farmstead may face.

The cattle yard is separated from the highway by a small pasture which can be used as a back lane, as in the preceding plan.

The location of the well, southwest of the house, is assumed to render it free from contamination by drainage from the poultry or cattle yards. The pump and engine or windmill need not necessarily

be placed directly over the well and hence are located in a pump-house between the house and barns, where they are readily accessible.

Sewage from the house is disposed of through a septic tank and distribution field located in the pasture east of the house.

THE FARMSTEAD SOUTH OF THE HIGHWAY, FRONTING NORTH.

The farmstead located south of the highway lends itself readily to a compact, convenient arrangement as illustrated in figure 8. But in the planning of the layout there arises the problem of the dwelling which should present an attractive exterior to the highway on the north and yet have living rooms with the desirable south and

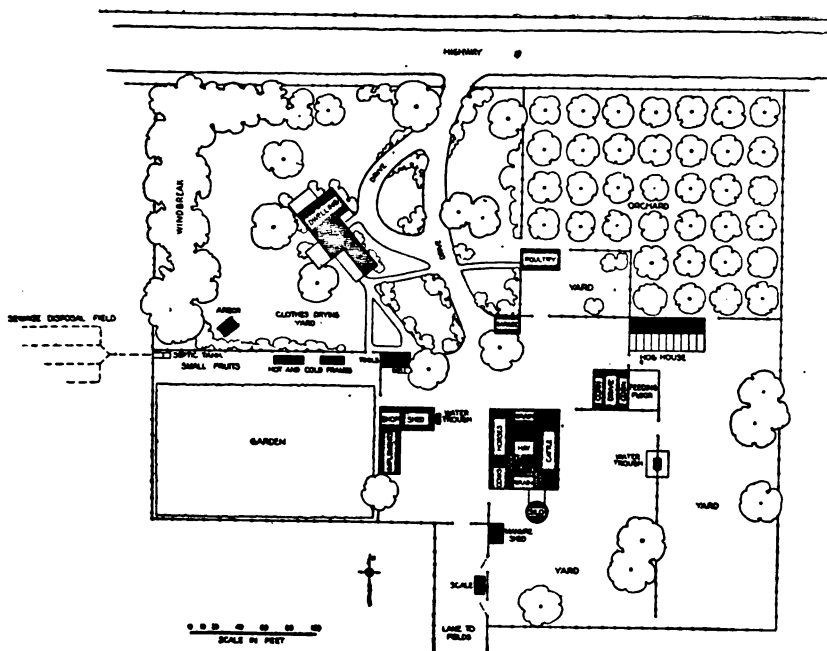


FIG. 8.—Farmstead lying south of the highway.

west exposure. There are a number of solutions depending upon the requirements of the family and the type of building. The average small square box of a house does not lend itself to this situation. One solution is indicated in this layout in which the same house used in the other plans is placed at an angle to the road. The advantages of turning this particular house in this way are apparent. The living room looks out upon the highway, but at the same time is made cheerful by sunlight from the west and south. The dining room faces the southwest. The kitchen commands a view of the highway and the entrance drive and yard are under the observation of the housewife in the kitchen. The rear porch, adjacent to the wash room and dairy, may be conveniently entered from the barns. Generally the best results are obtained by planning the house and

other buildings for the particular site selected for them having in mind the general considerations that have been illustrated.

The main entrance drive affords direct access to the outbuildings, yet is laid out with the pleasing effect of curved lines and the avoidance of the dust nuisance in view.

Here again, the location of the barn is such as to protect the house as much as possible from odors from the barnyard. The barn is of the same type as has been used in the other layouts and the same relation of the interior arrangements to the points of the compass has been retained. The adjacent hog and cattle yards permit of a convenient hog and cattle feeding arrangement similar to that in the farmstead east of the highway. The single-row hog house has been used again here for the reasons mentioned in the description of the farmstead west of the highway. The orchard serves the triple purpose of providing a windbreak for the yards, a poultry run and a supplementary hog run.

The relation of the implement shed, wagon shelter, and shop to the house and stable and to the lane leading to the fields is such as should be sought for. The scales, between the two cattle-yard gates, serve for weighing cattle, hogs, and corn as it comes from the fields.

Water-supply and sewage-disposal systems have been indicated with the precautions against contamination of the water in mind.

In conclusion, let it be understood that the four layouts illustrated are not schemes designed to fit all farms similar to them in character and location. They are presented merely for the purpose of making clear the application of general principles. Every farm has its own natural conditions and every farmer his individual methods and practices, and these conditions will influence the design of the individual buildings and the general grouping.

Complete working drawings for the following buildings indicated in the four plans may be obtained by writing to the Division of Rural Engineering, Bureau of Public Roads, United States Department of Agriculture, Washington, D. C., referring to the serial number of the building or buildings desired:

Dwelling, serial No. 540-1-2 (652-3).

Barn, serial No. 612-13.

Silo, drawings and bills of materials for various sizes and types.

Implement Shed. Wagon Shelter and Shop, serial No. 570.

Corn crib, serial No. 521.

One-row hog house, serial No. 683.

Two-row hog house, serial No. 680.

Manure shed, serial No. 1095.



FARMERS' BULLETIN 1133
UNITED STATES DEPARTMENT OF AGRICULTURE

**FEEDING
GARBAGE
TO HOGS**



WHEN PROPERLY MANAGED, the feeding of garbage to swine is a practical means of pork production. In addition, it helps to solve a problem which confronts many cities and towns—that of effective and economical garbage disposal.

Methods of feeding garbage to swine vary considerably and are still undergoing changes and development. This bulletin sets forth the general principles necessary for success, rather than attempting to establish definite methods or to discuss details of hog raising. With the general principles in mind, the reader should be able to work out details to meet his particular conditions.

Contribution from the Bureau of Animal Industry

JOHN R. MOHLER, Chief

Washington, D. C.

August, 1920

FEEDING GARBAGE TO HOGS.

F. G. ASHBROOK, *Animal Husbandry Division*, and A. WILSON, formerly of
Animal Husbandry Division.

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WASTE CONVERTED INTO AN EDIBLE PRODUCT.

GARBAGE is fed to hogs in a great many localities with varying degrees of success. The information given in this bulletin is intended to familiarize interested persons with the possibilities of the business when it is intelligently managed.

Feeding garbage to hogs in a proper manner makes possible the conversion of city waste into wholesome meat, thus giving back to the city a supply of food and at the same time affording the city an economical and efficient method of garbage disposal. Of 66 cities estimated as having populations in excess of 100,000 each in 1916, more than 30 per cent reported that their garbage was disposed of by feeding to hogs, and of the 544 cities of between 10,000 and 100,000 population from which reports were received by the United States Food Administration, more than 36 per cent made like reports. This means that even when the production in cities of less than 10,000 inhabitants is not considered, nor the suburban farm population which disposes of almost all its garbage by feeding, the waste food products from over 8,000,000 people are being fed to hogs. This product is sufficient, if handled and fed under ideal conditions, to produce approximately 80,000,000 pounds of pork a year. But experience shows

¹ Portions of this bulletin are based on information in the U. S. Food Administration bulletin, "Garbage Utilization."

that in actual practice scarcely more than 50 per cent efficiency may be expected, which means that about 40,000,000 pounds of garbage-fed pork is sold each year.

GARBAGE VARIABLE IN COMPOSITION.

Garbage ordinarily is all refuse accumulations of animal or vegetable matter which had been intended for human food. It is generally composed of scraps, peelings, fruit remnants, and spoiled food, and is rather variable in composition. Ashes, paper, manure, and street sweepings are not included in the definition of the term "garbage."



FIG. 1.—A typical cartload of municipal garbage collected in summer.

The composition of garbage depends largely on its origin and the season of the year. Garbage from hospitals and institutions is of excellent quality, as is also that of Army camps. Hotel and restaurant garbage, on an average, is next in food value, and ordinary municipal garbage is somewhat lower.

Analyses of cantonment garbage, by the Bureau of Chemistry, give the following composition on an air-dry basis:

	Per cent.
Protein.....	15 to 18
Carbohydrates.....	31 to 69
Fat.....	13 to 33
Ash.....	16 to 36

A sample of municipal garbage from Louisville, Ky., analyzed by the Kentucky experiment station, showed the following results, on an air-dry basis:

	Per cent.
Protein.....	21.5
Carbohydrates.....	41.8
Fat.....	23.4
Ash.....	13.3

VALUE OF GARBAGE FOR FEED.

A person considering a garbage-disposal contract is preparing to take certain risks and the risks warrant a commensurate return on his money.

In most cases it is believed that the value of the garbage will not be sufficient to pay the cost of collection and transportation. When



FIG. 2.—The same garbage as shown in the preceding figure, spread out. The method of feeding and the equipment illustrated are typical of what may be expected from short-term contracts.

a contractor both collects and disposes of the garbage it is unlikely that the work will be done without cost to the city unless the quality of the garbage is exceptional and there is keen competition for the material.

Experience shows that 50 pounds of garbage may be expected to produce 1 pound of marketable pork, live weight. With pork on the

hoof at 15 cents this would give gross value of \$6 to a ton of garbage, less the cost of labor and materials at the farm, haul involved, interest on investment, and depreciation on buildings.

HOUSEHOLD CARE OF GARBAGE.

The wholesomeness of garbage depends greatly on the care it receives in households. Tin cans, glass, paper, oyster shells, sawdust, soap, and other foreign materials when mixed with garbage may cause numerous losses of hogs.

The problem of keeping garbage free from injurious articles is primarily one for municipal control, involving suitable announcements to the public that garbage is being fed, enlisting the cooperation of civic bodies, and the enforcement of ordinances bearing on the proper care and handling of garbage.

Undoubtedly a great deal of the difficulty with the mixed material is due to carelessness, but the admixture of some of the objects mentioned can not be due to it entirely. Broken crockery, cutlery, paper, and meat skewers are not naturally associated with garbage. A large part of the trouble is due to the householder's lack of knowledge that the garbage is being fed and that foreign products in it are injurious.

It is important, therefore, to keep the public continually advised that the garbage is being fed. Individual cases can be handled usually by a courteous notice that the materials found with the garbage are very injurious to hogs. Word to the local press that one or more hogs have died from eating foreign material in garbage will generally be treated as "news," and the public will be reminded of its responsibilities. The various civic officials must give their hearty cooperation, and their notices to the public should explain that there is a reason for the various ordinances, that they are not simply "red tape," and a great improvement will be observed.

The requirements should make garbage noncollectible if it contains harmful materials or is so handled that injury to hogs may result. In addition to the foreign articles already mentioned, dish water should be excluded. Water not only adds to the per ton cost of collection but is likely to contain lye, strong soap, or washing powders—things which are not good for the digestive system of hogs.

In line with the policy of keeping out water the receptacles should be kept covered. This should be done for the further reasons that garbage in a well-covered receptacle is inaccessible to stray cats or dogs, is fly proof, and confines odors. Obviously such receptacles should be made of rust-resisting metal and kept water-tight.

FREQUENCY OF COLLECTION.

Aside from sanitary reasons, the frequency of collection is important in that fresh garbage has greater feeding value. In northern cities collection should certainly be made three times a week during the summer months. Once a week during cold weather might be sufficient from the feeding standpoint, but household requirements warrant at least two collections a week. In southern cities daily collection should be made during hot weather, while



FIG. 3.—The tank type of wagon is especially well adapted for hauling garbage.

three a week may be sufficient in the winter. Because of its more rapid accumulation, as well as superior quality, garbage from hotels and restaurants may well be collected daily.

If the disposal of garbage by feeding lowers the cost of disposal in any city, the question of using such savings for more frequent collections deserves consideration. The greater food value of fresh garbage is, of course, the chief reason for frequent collection.

WHO SHOULD MAKE COLLECTIONS.

It is generally advisable for the city to collect garbage by municipal facilities, even though its disposal by contract is deemed advisable. The municipality can generally overcome collection difficulties better than a contractor. With contract collections details must be definitely stipulated, and they are not so readily changed when conditions vary. With municipal collections changed conditions can be met more readily.

It is believed also that more competition can be obtained on a contract for disposal only than on a contract for both collection and disposal. The difficulties experienced with disposal are not so detailed as with collection.

METHODS OF UTILIZING GARBAGE AS A HOG FEED.

There are two feeding methods worthy of consideration, the first by the municipality, the second by the individual, association, or corporation. Contracts made individually with a number of feeders



FIG. 4.—A type of wagon that should not be used for hauling garbage.

are unsatisfactory and lead to difficulties. This has been tried in a number of places and found disadvantageous to both the city and the contractors.

In the first place the amount of garbage produced varies from season to season, and even from day to day. It is difficult to proportion this varying quantity among a number of feeders when each feeder must provide stock enough to consume the maximum amount which he might receive on any given day. It is impossible also to prevent a surplus if a certain feeder sells his stock and leaves the city with an accumulation of garbage and no way of disposal. With a number of individual feeders no heavy bond can be obtained by the city.

DISPOSAL STIPULATIONS.

In making contracts for disposal by feeding a comparatively long-time contract is advisable. It is obvious that with one-year con-

tracts the cost to the city must be excessive as compared with a longer period, since the contractor must cover the cost of his equipment in the price bid.

An additional advantage of comparatively long contracts or municipal operation is that sanitary standards can be insisted upon, which, because of their cost, would be prohibitive with a one-year contract. With a one-year contract cheap shelter, fences, and equipment will have to suffice. With a contract for a longer period the city can stipulate and the contractor would be willing to furnish structures of a more permanent type.

Any contracts to be awarded, however, should require standards that would permit no nuisance at the plant. Obviously in a settled community the opportunity for a nuisance would be greater than in a strictly suburban territory, and stricter standards would be needed. A suburban location for a farm is therefore more desirable, but lengthens the haul and thus increases costs. With wagon or truck haulage, distance is an important factor, but if the garbage has to be transferred from the collecting vehicles to rail transportation, the distance of the farm from the municipality is not so important, the cost to transport 5 miles being little less than to transport 20 or 25.

LOCATION OF FARM.

A hog farm should be located on soil that drains readily, preferably sand or gravel. Likewise, because of better drainage, it is advisable that the land be rolling. Quarters for the hogs should be located for warmth in winter and coolness in summer.

Garbage-fed hogs require abundant drinking water. If any streams or brooks are included in the property they should be carefully traced and their purity established or else fenced off so that the animals will drink pure water otherwise supplied. Although any practical method of watering may be used, automatic drinking fountains have several advantages, among them being the ability to keep the water from freezing in winter.

The size of the farm necessary varies with the system of handling. With feeding outdoors in all but extreme weather, about 50 pigs per acre is a good working average. Under cover the number can be increased to from 400 to 600 an acre.

EQUIPMENT.

The type of shelter and feeding equipment depends largely on the climate, nature of the contract, and future plans for the development of the farm. The equipment for a hog-feeding establishment where

swine are fed but not bred and raised is somewhat simpler than when arrangements must be made also for brood sows and their litters.

The essentials of shelter, as for the ordinary hog farm, are dryness, warmth, and general comfort. In cold weather the hogs should have access to a shelter free from rain and snow and where they will find warm, dry bedding. Equipment may include self-feeders, troughs, or platforms, depending on personal preference and the kind of garbage fed. All the methods are used with varying success, but platforms appear to be best adapted for feeding ordinary mixed garbage. Garbage fed on platforms is more readily accessible to the animals. Self-feeders are likely to need attention to prevent



FIG. 5.—Spreading the garbage on portable feeding floors, Home Farm, Worcester, Mass.

clogging when the garbage contains melon rinds or corncobs or in case the garbage freezes. Troughs are still less desirable but are sometimes used for feeding garbage that is semiliquid.

With long-time contracts more pretentious equipment can be installed, permanent rather than temporary houses may be erected, and concrete instead of board platforms provided. In such event the breeding and raising of the stock would probably be undertaken and at least one of the houses provided with heat and artificial light. Under no conditions, however, should the animals be kept in small pens. Considerable range is necessary for the successful operation of a piggery where garbage is fed, though fattening stock may be kept in close confines for a limited time.



FIG. 6.—Hogs eating garbage from the portable feeding floors, Home Farm, Worcester, Mass.

BREEDS TO BE USED.

Practically every breed of hog is fed successfully on garbage. The tendency is to cross the short-bodied hog with the bacon type. In some instances the boars are of the short-bodied type, while in other cases short-bodied sows are used.

With short-term contracts, the tendency is to buy stock at from 75 to 100 pounds in weight, and the effort is to get a thrifty hog that



FIG. 7.—Portable self-feeders, an inexpensive type of garbage-feeding equipment.

will put on weight rapidly. The number of pigs raised to maturity with garbage-fed stock is about the same as with grain-fed.

BUYING COMPARED WITH RAISING FEEDERS.

There is a difference of opinion among garbage feeders as to the relative merits of hogs raised on garbage from the time of weaning and those purchased on the market at about 100 pounds in weight. Some assert that the garbage-fed hog has not the strength of the other hog; others will handle feeders only when their regular stock is unable to consume the amount of garbage available.

A hog accustomed to garbage early in his life should be the more successful as a rule. The feed is more bulky than grain and requires



FIG. 8.—These inexpensive portable platforms were used in the same feed lot with the self-feeders shown in figure 7.

a greater stomach capacity if the same amount of nourishment is to be assimilated. The hog raised on garbage is started as a garbage-fed pig, and his stomach is capable of being distended far beyond that of a grain-fed hog of equal age.

Feeders who purchase the greater part of their stock generally get hogs when they are at an age and weight at which they can make the largest and most profitable gains. There is, however, a possibility that feeders will have considerable difficulty in purchasing the kind of animals they desire for feeding. In buying pigs, the buyer near the point where a considerable number of hogs are placed on the market has a distinct advantage. Local conditions will undoubtedly be the greatest factor in deciding this question. If the farm is operating on a one-year basis the expenditure for equipment necessary for raising is not justified. Pigs can be purchased more cheaply. If several years of operation are certain, raising the animals may

prove the cheaper. Satisfactory results are obtained under both systems; the management is the essential factor.

METHODS OF FEEDING.

The two general methods of feeding depend primarily on how the material is delivered to the farm. When in wagons or in motor trucks it will probably be advantageous to have what are known as feeding lots. These lots are about an acre in size and contain one or more feeding platforms, made of lumber and of sufficient size to hold a load of garbage as delivered. The platforms are on skids and have a low rail, a 2 by 4, nailed on edge, to prevent the garbage from being shoved off the platform.



FIG. 9.—Permanent hog houses used on the Home Farm, Worcester, Mass.

The pigs are permitted to enter the feeding lot only after the garbage has been dumped and the vehicle has left the lot. This prevents injury during unloading and keeps garbage from being thrown on the pigs.

Before the next feeding time the hogs are driven out of the lot, any bones from the garbage are gathered, and the platform cleaned. The platforms are moved from time to time to different locations and different lots. The lots vacated should be plowed, thus eliminating the danger of odors from spilled garbage and in addition retaining the fertilizer value of the garbage and manure. The lots plowed should be sown to some forage crop and eaten off by the hogs.

Where delivery is made in carload lots the labor expense of rehandling the garbage may be so great that it will be more advisable to have the feeding platforms adjacent to the railroad tracks. Plat-

forms that are not to be moved should preferably be of concrete and be ample in size. Narrow platforms or troughs in time become so eaten by the garbage juices that they are hard to clean. Besides, it is much better to spread the material out on a flat surface where the hog will have an opportunity to select his feed.

When garbage can be graded the best of it should be fed to fattening stock or to sows with young pigs. When open-lot feeding is practiced this is a simple procedure, since the material collected in the better portions of the city can be reserved for these particular purposes. With carload lots the same effect is produced by first



FIG. 10.—Individual houses used collectively on the Home Farm, Worcester, Mass.

admitting only the fattening stock to the platforms. After these animals have become satisfied a second lot, such as young shoats, is let in. In the same way a third or even a fourth lot is given an opportunity. Not only is the better garbage eaten by the stock that needs it most, but the garbage is eaten more closely. The last lot, generally brood sows, is kept more hungry and can be relied upon to clean up all edible material remaining.

The feeding of frozen garbage during the winter months is not advisable. It may be unavoidable, but it must be remembered that before this feed can be digested its temperature must be raised to that of the stomach. This requires a certain amount of energy, more cheaply supplied by artificial means than by the body heat of the animal. Much frozen garbage is fed, but less gain in weight is

obtained. If the material is thawed before feeding, the gains are asserted to equal those of other seasons of the year.

NUMBER OF ANIMALS PER PEN.

The losses due to "piling up" are so heavy that most hog raisers have very positive ideas as to the number of animals per pen. Some say that as low as 10 is the number to be allowed in a shelter 10 by 20 feet, floor dimensions.

Individual pens should be provided for each brood sow, or at the most two sows should share the same pen. Upon being weaned the



FIG. 11.—Sanitary hogpens and feed lots are essential to successful hog raising. (Photograph by courtesy of District of Columbia Workhouse Farm, Occoquan, Va.)

young pigs may be kept 8 or 10 to a pen until about 2 months old. Efforts should be made to keep in each pen pigs of approximately the same size. When between 60 and 75 pounds in weight they can be turned out into comparatively large lots, one-half acre or more. The larger the animals the more can be put together in a single inclosure without danger to their development. Records indicate that as high as 500 or 600 animals have been kept in a single inclosure without sufficient piling up to cause harm.

STERILIZED COMPARED WITH RAW GARBAGE.

There has been considerable discussion throughout the country on the desirability of sterilizing garbage before feeding, but the best evidence is in favor of feeding garbage raw rather than cooked. At practically all farms where sterilizing apparatus was formerly

installed, at considerable expense, it is no longer in use. The difficulty is this: Sterilization causes injurious acids or other soluble substances of harmful nature to spread throughout the garbage. Raw garbage, on the other hand, better enables the hog to use his powers of feed selection and to refuse any ingredients that are unappetizing or are an unnatural feed. These remarks apply especially to soap, coffee grounds, acids in fruit skins, and spoiled products. Persons who are not familiar with hogs do not usually realize the remarkable instinct which these animals display in choosing feed which is beneficial when they have opportunity to do so. The most successful hog raisers give their animals a great amount of latitude in selecting their feed, and obtain the best and most economical results by so doing.

As regards carefully graded garbage from hotels, restaurants, and Army camps, sterilization does not seem to be so objectionable. This, however, is a special type of garbage.

Experimental evidence also, from the standpoint of daily gains in weight, slightly favors feeding raw garbage.

Briefly, cooking is an expensive operation and is regarded by many successful feeders as useless and even injurious, owing in part to the formation of organic acids. They agree that cooking causes the material contained to be so thoroughly mixed that it is impossible for the hogs to make selection in eating. A hog can balance its ration on raw garbage, whereas, if the material is cooked, the hog has no choice in the selection of its feed. These comments do not apply to moderate heating for the purpose of thawing frozen garbage to make it more palatable and more readily eaten.

GAIN IN WEIGHT PER POUND OF GARBAGE EATEN.

A number of careful tests have shown that a gain of about a pound a day can be expected with growing hogs fed on garbage, provided there are no losses. This means roughly that a ton of garbage will produce 100 pounds of gain on a live-weight basis. It does not mean, however, that tons of garbage as produced multiplied by 100 equals the live weight to be put on the market. A certain percentage of loss in stock is always to be expected and even with the fullest cooperation with householders and city officials, a certain amount of inedible material and even inedible garbage will always be present.

Some feeders state also that the quality of the garbage now produced is not so good as that of a few years ago, and that more garbage must be eaten to produce a pound of gain. Though not definitely established, it is reasonable to conclude that high prices result in a lower quality of food reaching the garbage can. We recommend that to cover losses and a possible decrease in the quality of the garbage

fed, the amount of marketable live weight be placed at 1 pound to 50 pounds of garbage. With careful management the ratio could be narrowed considerably.

USE OF SUPPLEMENTARY FEEDS.

Most garbage is more or less a balanced ration and no supplementary feeds are required. We find, however, in a number of places that animals are finished off on corn, barley, wheat middlings, or similar feeds. As a rule no other feed than garbage is provided. With hotel garbage and other special garbage a certain amount of roughage may be desired or even necessary. The opinions of different hog raisers vary greatly; the personal qualifications of the manager appear to be the most important factor.



FIG. 12.—Swine can be raised on farms that are somewhat rolling. (Photograph by courtesy of District of Columbia Workhouse Farm, Occoquan, Va.)

Tests to determine the value of supplementing garbage with grain were conducted at the Michigan, New Jersey, Mississippi, Kentucky, and Iowa experiment stations. There were 140 pigs used in all of these tests. The feeding periods varied from 20 days, the shortest feeding period, to 211 days, the longest period. The supplementary feeds used were shelled corn, barley, middlings, corn meal, and forage crops.

In the case of garbage alone 23,534 pounds of garbage produced 1,162 pounds of pork (live weight), which was at the rate of 2,025 pounds of garbage to 100 pounds of pork (also live weight). In the case of garbage and grain 438.5 pounds of grain and 21,329 pounds of garbage produced 2,169 pounds of pork. This was equivalent to 202 pounds of grain and 983 pounds of garbage, producing 100 pounds of pork. A calculation from these figures shows that 100

pounds of grain equals 516 pounds of garbage when the grain is fed as a supplement.

The feeding value of garbage, especially the better grades, is such that it is seldom economical to use a grain supplement. However, when grain is reasonably low in price, good results might be obtained by feeding garbage alone during the summer months, when there is ordinarily a large production of garbage, and then finish the hogs on a grain ration. Greater gains per day can be made with grain supplements, but at a greater cost than on garbage alone.

QUALITY OF PORK PRODUCED.

We have not been able to find any market where garbage-fed hogs are generally sold at a lower price than grain-fed animals and there is no logical reason why garbage should be bad for hogs.

Garbage-fed hogs were raised at the experiment station of a Middle Western State and marketed at the same time as hogs fed corn and other grains. The carcasses of the garbage-fed hogs could not be distinguished from corn-fed hogs by the experts of one of the large packing houses, and were given even a higher grading than some of the hogs fed on certain grains.

Hogs fed garbage at the New Jersey station were slaughtered at the end of the test. Expert meat judges from two well-known packing concerns in the East inspected all cuts of meat. Little or no criticism was offered on any of the carcasses. It so happened, however, that in two instances carcasses which had been fed on cooked garbage were referred to as being a trifle light in color, while two carcasses from the grain-fed lot were criticized for lack of firmness and fineness of texture in both fat and the muscle tissue.

The Mississippi station sold a lot of garbage hogs on the St. Louis market. All the carcasses were firm and the dressing per cent of these hogs varied from 76.66 to 81.04.

An objection sometimes raised to garbage-fed hogs is that the hogs are liable to be infested with trichinæ. It is true that isolated cases have been found, as in grain-fed stock, but we do not believe that there is any evidence to-day that shows garbage-fed hogs as a class to be more commonly affected with trichinosis or tuberculosis than grain-fed hogs. The health officer of a large New England city which disposes of its garbage by feeding says: "I believe garbage-fed pork is as wholesome as any that can be obtained. I eat it myself when I get it, and I wish I could afford more of it. I do not see any grounds for the belief that such pork is unwholesome." Thoroughly cooking pork from any source destroys all danger from the parasite causing trichinosis. The Department of Agriculture urges thorough cooking and condemns the practice of eating raw pork.

HOG CHOLERA AND GARBAGE FEEDING.

Every garbage feeder should realize that the material he is feeding may contain raw scraps of meat from hogs that were infected with cholera, and that instead of being exposed to the disease once or twice during their lifetime his animals may be exposed daily. Immunization is accordingly far more important than in the case of grain-fed stock. Garbage feeders must recognize that their hogs are exposed constantly and that immunization is highly important for safety.

Some successful garbage feeders use the single or serum-alone treatment and aim to repeat about every 6 or 8 weeks. This is expensive from the standpoint both of labor and cost of serum used, as the immunity conferred may not last longer than 4 weeks and its effectiveness is doubtful. Best results are obtained by using the simultaneous or combined serum and virus treatment. Experienced men, using good potent serum and virus, can vaccinate a herd of hogs by this method and obtain permanent immunity with a very small percentage of loss. Incompetent practitioners or careless methods, on the other hand, may be the means of spreading the disease.

Actively immune sows transmit to their offspring a passive or temporary immunity. As a rule this immunity will last until weaning time and in some instances it may persist somewhat longer. Before the pigs are weaned the single or serum-alone treatment may be given, to be followed later by inoculation with the simultaneous method, or the simultaneous treatment may be given in the first place and the serum-alone treatment omitted.

We find that where selected garbage is fed, even if efforts to sterilize by cooking have been made, a great deal of trouble is experienced when immunization is not practiced.

Because of the lasting immunity conferred, the simultaneous treatment for cholera control in hogs fed on garbage is preferable to the "serum-alone" treatment. The cost is practically the same.

The doses of both virus and serum should always be ample. It is of the highest importance that virus of full virulence be used in treating hogs kept under garbage-feeding conditions.

TUBERCULOSIS AND OTHER DISEASES.

Dependable estimates indicate that 90 per cent of the hogs raised in Massachusetts are fed on garbage, yet statistics show that of more than 10,000 hogs slaughtered in 1917 under inspection in that State only 169 were found to be infected with tuberculosis.

Hogs contract tuberculosis principally from cattle, either by following tuberculous cattle in the same lot, by consuming unpasteurized skim milk from cows having tuberculosis, or by feeding on diseased carcasses. The feeding of garbage is considered to be an uncommon cause of tuberculosis in hogs, and the short duration of the average feeding period greatly reduces the probability of losses from that disease.

To avoid pneumonia, the main effort, as with grain-fed hogs, is to prevent the animals from becoming overheated and then cooling



FIG. 13.—Hogs eating garbage from platforms, Hull, Mass.

off too rapidly. Practical measures of avoiding it are good ventilation, dry sleeping quarters, sanitation, and prevention of overcrowding. As well as being undesirable for nutritive reasons, the feeding of frozen garbage has a tendency to lower the vitality of the animals, and makes them more susceptible to disease.

Cholera, it should be remembered, is not the only disease to which hogs are susceptible; consequently simultaneous inoculation will not prevent all losses. It is highly desirable, therefore, to feed garbage in such condition and care for the hogs in such manner that the vitality of the animals may be kept to the highest point.

Diseases other than cholera can be expected to appear among garbage-fed hogs in about the same degree as with grain-fed stock. The treatments are identical and the same care is required.

SANITARY STANDARDS.

In garbage, which spoils easily, sanitary measures are relatively more important than with a practically sterile grain. Manure and uneaten garbage should be cleaned up every day and either composted with dry earth or spread on the ground and immediately plowed under.



FIG. 14.—Feeding pens at the garbage plant, Fort Bliss, Tex.

The paint pot and whitewash brush at a pig farm can not be too much in evidence for the safety of the herd. Efforts should be made, likewise, to keep rats, crows, and buzzards under control. It is advisable to make buildings ratproof.

ESTIMATES OF EXPENSE AND REVENUE.

Any estimates of the cost and returns from garbage disposal are so dependent on the conditions in the community that figures for one locality can not be regarded as dependable for another. The following general statement, however, illustrates a typical case. The figures deal with garbage disposal by feeding as practiced in Worcester, Mass. This city is selected because of the successful

operation of its municipal piggery and more particularly as it came to be used to illustrate the values recoverable in successive years of operation.

Statement of garbage-feeding conditions at Worcester, Mass.

Population.....	185,000.
Area.....	38.4 square miles.
Topography.....	hilly.
Frequency of collection.....	twice a week.
Distance of farm from the city.....	3½ miles.
Distance of farm from the center of garbage production.....	6½ miles.
Cost of collection (including haul to farm).....	\$7.25 a ton.
Area actually used for pig farm.....	40 acres.
Quantity of garbage fed, 1917.....	6,514 tons.
Minimum number of hogs in herd.....	2,000.

(Only about 60 per cent of garbage produced was fed at farm, the remainder being fed by private collectors.)

Approximate investment in disposal equipment.

Forty acres at \$100.....	\$4,000
Buildings, fences, etc.....	35,000
Other equipment.....	1,000
	<hr/>
	40,000

Operating expenses (1917).

Six caretakers at \$840.....	\$5,040
Additional labor.....	900
Grain and bedding.....	1,896
Serum and virus.....	2,581
Repairs to buildings.....	1,000
Miscellaneous, supervision, light, heat, interest, teaming.....	3,500
	<hr/>
	14,917

Revenue and expense.	Total.	Per ton fed.
Revenue.....	\$51,737.33	\$7.94
Expenses.....	14,917.91	2.29
Difference.....	36,819.42	5.65

In 1915 the entire herd had been disposed of and Worcester started in to build up a new herd under conditions almost similar to those to be faced by any one first going into the proposition. The following figures cover the principal revenues:

Revenue from September 1, 1915, to December 1, 1917.

Swine sold, 1916-----	\$13, 212. 84
Swine sold, 1917-----	44, 487. 33
Insurance on stock lost by fire-----	4, 350. 00
Stock on hand December 1, 1917 (2,110 head)-----	42, 000. 00
	<hr/>
	104, 050. 17
Less stock purchased September, 1915, to December, 1917-----	10, 727. 61
	<hr/>
	93, 322. 56

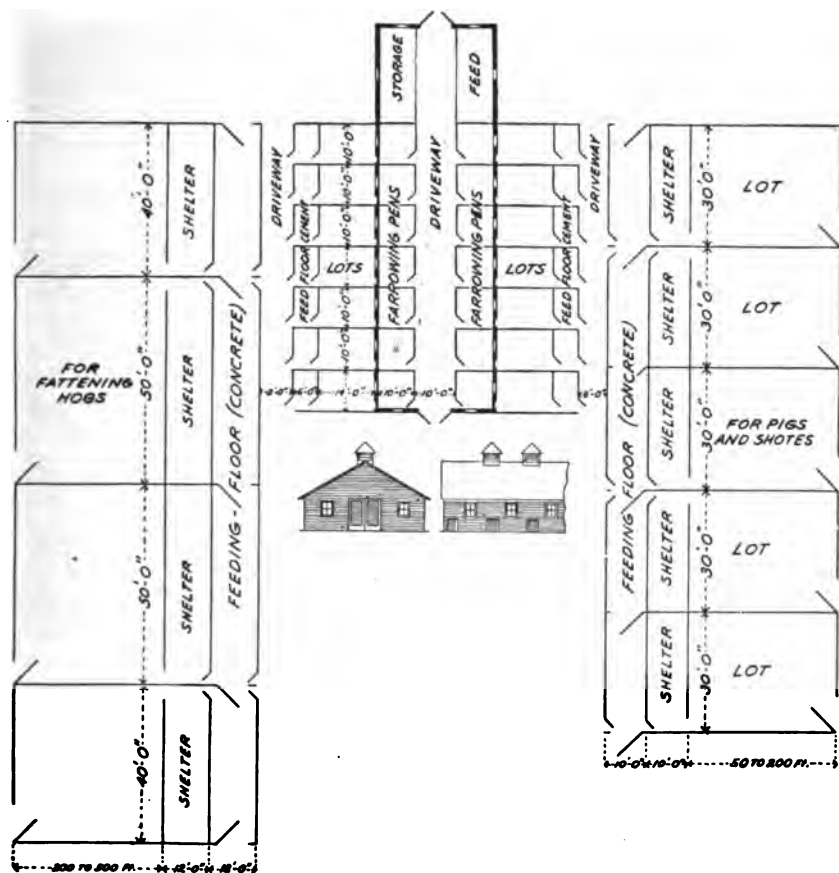


FIG. 15.—Suggested arrangement of plant for feeding garbage to hogs.

The estimated operating expense during the period (based on the statement of expenses for 1917) is \$33,750, making a net return of over \$59,000 for 2 years and 3 months of operation.

None of the foregoing figures include depreciation or interest on money invested in livestock. Depreciation on buildings is covered by repairs made, while the farm itself is considered as suffering no depreciation.

No credit has been allowed for manure produced, although its quantity was so great that no other fertilizers were purchased for use on the entire farm of 596 acres.

Additional figures on results of garbage feeding are given by Dr. B. T. Woodward, veterinary inspector at United States Naval Academy, Annapolis, Md., who reports an experiment with 110 pigs averaging 101 pounds each. Six pigs died within 10 days of arrival, and 1 died after four months' feeding.

Summary of experiment at Annapolis, Md.

Average time on raw garbage not supplemented with pasture or any other ration.....	days	123
Average gain, live weight.....	pounds	119
Average dressed weight.....	do	186
Average dressing per cent.....	do	84.8
Purchase price per pound.....	cents	17½
(The purchase price includes cost of the swine, cost of immunization, quarantine, freight, attendant expenses, and expenses on purchasing trip.)		
Average sale price per pound, dressed.....	cents	25
Average gain (per hog).....		\$27.57

SUNDRY GARBAGE PRODUCTS.

Prior to the World War thousands of tons of garbage were collected and subjected to various treatments, resulting in grease, commercial fertilizer filler, and various sundry products. In many cases rendering vats were used to extract the grease, which was then skimmed off, put into barrels, and sold for various purposes. The residue was carefully graded, in some cases run through steam evaporators, concentrated, and given the trade name of "stick." This product, which is of about the consistence of molasses, contains a great deal of sugar. An analysis made by the New Jersey station showed that it contained the following nutrients:

	Per cent.
Moisture.....	61.00
Nitrogen.....	1.30
Ash.....	5.81
Carbohydrates.....	31.89

SUMMARY OF OBSERVATIONS AND EXPERIMENTS.

Among the points of practical application in feeding garbage to swine, the following are of particular importance in the light of present knowledge on the subject:

The waste-food products of more than 8,000,000 people are being fed to swine and fully 40,000,000 pounds of garbage-fed pork are sold annually.

Garbage varies greatly in composition, but on an average and allowing for normal losses, a ton of municipal garbage may be expected to produce 40 pounds of marketable live weight of hog.

The garbage must be collected with reasonable frequency and be free from tin cans, soap, broken glass, and other undesirable or injurious foreign articles. The public should be kept informed that garbage is being fed.

Usually it is best for the cities to make the garbage collections and then dispose of the garbage to individuals, associations, or cor-



FIG. 16.—Garbage-feeding plant, Hull, Mass. Dumping the garbage on to the feeding platform.

porations on a contract basis, unless the city operates its own hog-feeding farm.

Long-time contracts are likely to be most satisfactory to all concerned; besides they tend toward a better class of equipment and more sanitary conditions.

The pigs to be fed may be bought as feeders or may be raised. Each method has given good results under suitable conditions.

Methods of feeding, handling, housing, and care may differ considerably so long as the essentials of sanitation and hog comfort are observed. Equipment for feeding should be adapted to the type of garbage available and to local conditions, climate, and transportation.

Raw garbage generally is better for hogs than cooked garbage. Frozen garbage, however, should be thawed before feeding.

As a rule the use of grain as a supplementary feed for the garbage is not an economical practice, but may be used to advantage when the supply of garbage is temporarily short.

Hogs to be fed garbage need to be immunized against cholera, preferably by the double or simultaneous treatment. Thorough immunization is very important because of the presence of raw pork scraps frequently deposited in garbage cans.

Garbage-fed hogs show no greater susceptibility to tuberculosis, pneumonia, or kindred diseases than grain-fed animals.

Pork from garbage-fed hogs is as good in quality as pork resulting from other feeds, and average garbage-fed hogs sell at practically the same prices as average grain-fed animals.

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CASTRATING AND DOCKING LAMBS

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and

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FARMERS' BULLETIN 1134
UNITED STATES DEPARTMENT OF AGRICULTURE

**Joint Contribution from the Bureau of Animal Industry
John R. Mohler, Chief, and the Bureau of Markets
George Livingston, Chief**

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THE LARGEST PART of the returns from farm flocks is derived from the sale of lambs.

In order that this source of income may be as large as possible, it is necessary to have the lambs in the best possible marketable condition.

Ram lambs and undocked lambs are discriminated against on the market because they are less well developed and lack a uniform and attractive appearance.

It is impossible to obtain as large gains or as good condition on lambs that have not been castrated.

This bulletin discusses how these operations may be done safely and effectively on the farm.

CASTRATING AND DOCKING LAMBS.

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ESSENTIALS IN THE PRODUCTION OF A GOOD LAMB CARCASS.

THE SHEEP INDUSTRY depends for a large part of its returns upon the lambs produced from the flock. The meat side of the industry is of great importance and bears a direct relation to the profits from the flock. Three essentials are necessary to produce a desirable lamb carcass: (1) good breeding, (2) proper feeding, and (3) castration and docking of the lamb. The most desirable and thus the most profitable lamb carcass can not be produced from lambs which have not been docked and castrated.

Agencies interested in the sheep business are making an effort to educate the American public to eat more lamb and mutton. If this effort is to be a marked success, the lambs must be properly bred and fed, and the carcass must be of a desirable character. While beef, pork, and lamb sell at somewhat similar prices, an increased consumption of lamb is dependent upon a supply that is at least as good in quality as the other meats.

The farmer does not market his bull calves as bulls, nor his boar pigs as boars. Why, therefore, should he market his male lambs as ram lambs rather than as wethers? The correction of this neglect by docking and castrating the lambs is vital, and upon a more general observance of the practice in the farm flocks hinge the real profits and more general success. If the industry is to be made to yield satisfactory returns, the docking of lambs and the castration of males not intended to be kept for breeding purposes should be attended to without fail at the proper time.

LARGE PROPORTION OF FARM LAMBS NOT DOCKED OR CASTRATED.

It is conservatively estimated that 80 per cent of the native lambs—those marketed from farm flocks—which reach the markets come undocked and uncastrated, and that the percentage of ram lambs among the offerings during the last year has been as large as ever before. The remark, "What a trashy lot of natives," is often heard in the sheep houses of the leading markets. This is because lambs, uncastrated, undocked, partly fat and partly lean, and showing no uniformity in weight, quality, or condition, come to market from the farm States weighing all the way from 40 to 100 pounds each.

On the other hand, the custom of docking all lambs and castrating the males is almost universal in the range flocks, and to this practice, in large measure, may be attributed the fact that lambs produced on our western ranges outsell native or farm-raised lambs at the market on the average from \$1 to \$1.50 per hundred pounds. It is true, of course, that uniformity in breeding is a factor in favor of the western lambs. It is certain, however, that had the flockmaster of the West not found castration and docking of lambs highly profitable, these operations would not be so commonly practiced in that great lamb-producing section.

ADVANTAGES OF CASTRATION AND DOCKING.

DISCRIMINATION IN MARKETS.

The severe discrimination shown by buyers against heavy ram lambs and the harmful influence on consumptive demand accruing from the slaughter of such great quantities of stock that can not make a satisfactory food product seems not to be fully realized. Certainly more vigorous efforts to improve the situation on the part of those directly interested in the welfare of the sheep industry should be made. Big, coarse ram lambs produce inferior meat, as do the thousands of thin, untrimmed, cull, native lambs that have to be slaughtered because the feeder will not buy them. It is not surprising that the consumer balks at purchasing such meat and forms a prejudice against it. With our markets flooded with low-grade lambs, the average consumer, an unskilled judge of meat on the block, has little chance of escaping frequent disappointment in purchasing that kind of meat and instinctively turns to other meats in which he feels he has more chance of getting a palatable food product.

In the fall of 1919 the Chicago market received large supplies of native lambs. During that period (and the condition reported is but a repetition of conditions prevailing in the summer, fall, and winter months of preceding years) the discrimination against ram lambs,

especially those carrying weight, was very marked. Packer buyers have demanded the throwing out of heavy ram lambs from loads, buying the bulk of such stock at from \$4 to \$5 per hundredweight below the price paid for the top end of the load.

Farmers and shippers sometimes state that they receive as much for their bucky lambs as they get for their ewe or wether lambs.

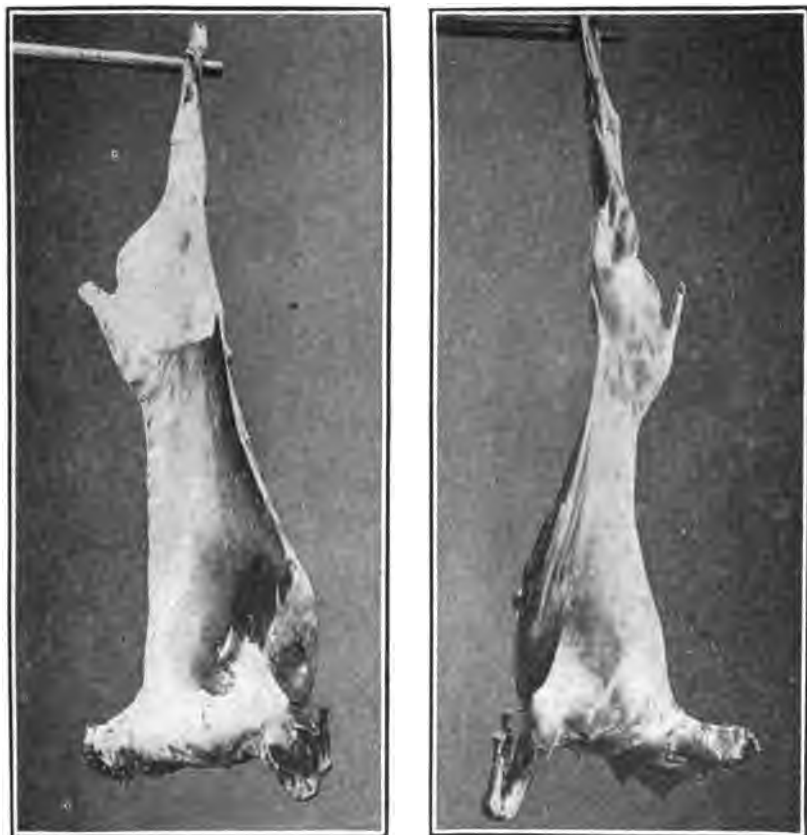


FIG. 1.—Which carcass do you prefer?

Wether carcass, smooth in the shoulder, short in neck, deep and thick over loin and in the leg, well finished and uniformly covered.

Bucky carcass, coarse in neck and shoulders, light in loin and leg, lacks covering and proper finish.

That is not really the case. Often at the central market, the salesmen, when busy, do not sort out the bucky lambs from a shipment and sell them separately, but their presence in the load is taken into account and a dockage is the result. Thus the ewe and wether lambs have to bring up the average of the sale, and the farmer or shipper is penalized because he has failed to dock and castrate. Thousands of heavy ram lambs have sold at from \$10 to \$12 on a market ab-

sorbing the general run of fat handy-weight native lambs at from \$14 to \$15, while the occasional straight load of well-conditioned ewe and wether native lambs has commanded premiums of from 25 to 75 cents per hundredweight over the highest sales of fat and handy but bucky lambs recorded on the same day's market. (See fig. 1.)

Buyers assert that the finished load of native ewe and wether lambs, comparatively uniform in weight and quality, is intrinsically



FIG. 2.—Cutting off end of scrotum.

worth the premium such stock commands over loads of bucky stuff or heavy ram lambs. This fact is well substantiated by the avidity with which they search out the first-named kind and by their frequent neglect of the bucky lots, even at the price discounts noted.

DOCKED AND CASTRATED LAMBS SELL ALSO AS FEEDERS.

In addition to the added value for slaughter of ewe and wether lambs over the bucky kinds, the producer who docks and castrates his lambs has a product that if not in good killing condition invites

competition from feeder buyers, consequently increasing their sale value. This competition is entirely lacking in the case of ram lambs. Another important reason for the castration of male lambs is found in the fact that better weight gains are assured than when such lambs are permitted to mature to the age of 5 or 6 months as rams. Every experienced lamb feeder must recognize the fact that the more quiet his lambs can be kept the bigger the gains they will make. The presence of even a few ram lambs causes restlessness in an entire



FIG. 3.—Testicles exposed.

flock, since the rams not only keep their own flesh down but also that of the other animals of the flock.

A LOAD THAT SOLD AT A PREMIUM.

In September, 1918, a well-known packer in Chicago received a load of ewe and wether native lambs direct from Louisville, where the stock was purchased at \$18.50 per hundredweight. At that time \$17 was considered practically the top of the market for "good" lambs, as the trade usually considers them, while "seconds" were

selling at \$13 and "thirds" down to \$10. This load of lambs, although costing on foot more per hundredweight than any native lambs were bringing in Chicago at that time, and far above the general top at Louisville, was pronounced by the buyer as being as well worth the money as any lambs his house had slaughtered for some time. He attributed this to the fact that the lambs were docked and castrated, and were uniform and well finished.

The discrimination made by packer buyers against bucky, undocked, uncastrated lambs is only justice to the lamb producers who



FIG. 4.—Pulling out testicles with the adhering cords.

practice docking and castration. By thus placing a premium on the right kind of lambs, in proper market condition, a service is being rendered to the sheep industry as a whole. It is to be hoped that country buyers, as well as packer buyers, and all branches of the trade will continue to emphasize this fact by notifying their shippers in making returns to them on their consignments. Such a step would be educational and help to correct the failure to dock and castrate native lambs.

CASTRATION.**BENEFITS OF CASTRATION.**

Very substantial benefits arise from the early castration of lambs. First, they make more weight at an earlier age—castrated lambs are more quiet, and so make better gains. Second, they are more easily managed—both sexes may run together at all times without the danger that the females will be bred. Third, early castration results in



FIG. 5.—Applying an antiseptic.

the production of a better carcass, as it prevents undue development of the head, neck, and the front quarters. As stated before, buyers severely discount uncastrated lambs to an extent ranging from \$2 to \$5 per hundred pounds in comparison with castrated and docked lambs of the same age.

METHOD OF OPERATION.

Castration is not dangerous if a little care is taken, and can be performed by any careful person who will follow directions. Lambs

should be castrated when they are from 7 to 14 days old. Choose a bright day; do not castrate lambs on a damp, chilly, or rainy day. Select from the flock all lambs that are to be castrated and fence them off so that they can be caught without undue excitement. Never worry or chase lambs before performing the operation. Provide a clean stall or pen for them to go back to after the operation is performed. The operator's hands must be clean and the knife disinfected.



FIG. 6.—Docking with knife. Note position of knife and operator's thumbs.

The lamb should be held against the body, as shown in the illustration. Cut off one-third of the lower end of the scrotum, or bag, so as to permit good drainage. Then expose the testicles, as shown in figure 3, and with the left hand force them out, holding them in this position by a firm grip between the thumb and fingers, which are held close to the abdomen of the lamb. Next, grasp the testicles firmly between the thumb and fingers of the right hand, as in figure 4, and draw them out with the adhering cords. The work should be done quickly but not roughly, and the testicles and adhering cords

should be drawn out with a steady pull. The wound should then be washed with a good antiseptic, such as a weak carbolic solution, or a creolin or lysol preparation, as shown in figure 5.

When lambs are older than 3 weeks before the operation is performed the cords should not be pulled out but scraped off with a knife back of the testicle. The scraping is done to prevent excessive bleeding.

Lambs should be kept quiet after they have been castrated. It is best to perform the operation in the morning, so that they can be watched during the day and attention given any that become too weak from loss of blood.



FIG. 7.—Equipment for docking with heated irons.

DOCKING.

BENEFITS OF DOCKING.

Lambs can be docked at the same time that they are castrated. When care is used both operations can be performed at the same time and labor saved, as the lambs will have to be caught only once. It should be a uniform practice to dock when the lambs are from 7 to 14 days old.

The lamb's tail renders no substantial benefit to the animal. Its presence is injurious because of the filth that accumulates around and beneath it. Moreover, lambs are more attractive and look neater and deeper in the leg and twist if the tail is docked. When the tails are left on females they are apt to fail to breed.

The two preferable ways of removing a lamb's tail are by using a sharp knife or the docking irons. One man holds the lamb while the other performs the operation.



FIG. 8.—Lamb in position to dock.

When docking with the knife the operator, by feeling on the inside of the tail, first locates the joint to be cut, which is about $1\frac{1}{2}$ inches from the body. He should then push the skin on the tail back toward the body of the lamb so as to leave some surplus skin to grow over the stub. The cut should be made quickly with a sharp knife. If any lamb should bleed too much a piece of cord may be tied very tightly on the stub of the tail close to the body, to stop the bleeding,

but the cord must be removed in a few hours or the tail will slough off.

When hot pincers or docking irons are used, no danger need be feared from loss of blood. Old sheep can be docked successfully in this way. The pincers should be heated to a cherry-red heat, not hotter, and the tail seared off at from 1 to 1½ inches from the body. (See fig. 9.) The wound will be seared over and no blood lost. When



FIG. 9.—Docking with heated irons.

the irons are used at proper temperature the wound will heal satisfactorily, but probably not so quickly as when the knife is used. The wound is also sterilized and needs no further attention. When the lambs are in a pen near at hand, with one man to catch them and another to hold them, from 9 to 12 lambs can be docked without heating the irons again. The lambs should be watched for a few days to see that they are recovering from the operations satisfactorily.

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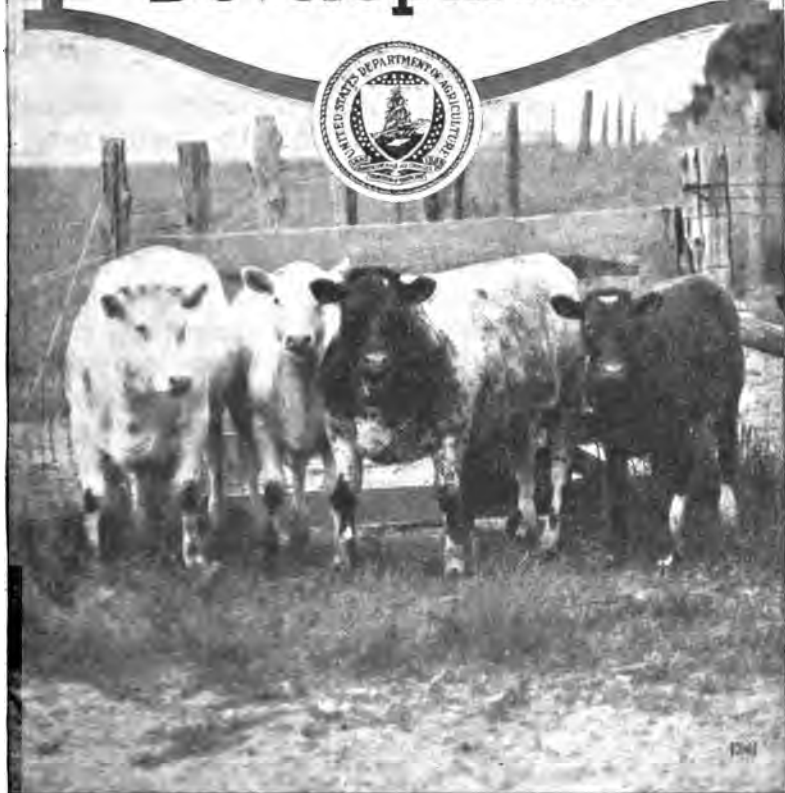
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FARMERS' BULLETIN 1135
UNITED STATES DEPARTMENT OF AGRICULTURE

The
BEEF CALF

Its Growth and
Development



THE PRODUCTION of a famous breeding animal or a noted winner in the show ring is a science and an art which can be attained only by those who know and admire cattle and never tire of working with them.

No doubt many a young farmer is ready to select his first purebred beef calf with the hope of developing it into such a useful and profitable individual. This applies especially to boys with experience in growing a calf for beef, and who have the necessary capital and sufficient feeds for the enterprise.

If a calf is to develop into such an animal, much depends upon the selection made, as well as the care and attention subsequently given it.

The following suggestions are offered as a guide in this undertaking and are intended primarily for the use of boys' and girls' clubs. The fundamental principles only are given, leaving the details to be obtained from other publications as experience is gained.

Available bulletins which may be obtained upon request from the United States Department of Agriculture or from the State agricultural college will give much additional information.

Contribution from the Bureau of Animal Industry

JOHN R. MOHLER, Chief

Washington, D. C.

August, 1920

THE BEEF CALF: ITS GROWTH AND DEVELOPMENT.

E. W. SHEETS,
Animal Husbandry Division.

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WHEN TO SELECT A CALF.

THE best time to select a calf is at a few months of age, when it may be seen with its mother, or, at any rate, before it is weaned. Observe the calf's mother. If she is a wide, deep-bodied cow with plenty of size and is giving a liberal supply of milk, you may be reasonably sure that the calf, if sired by a good bull and properly cared for, will grow into a useful breeding animal. Another advantage of selecting the calf at this time is that it may be taught to eat grain before it is weaned. However, since it is difficult sometimes to obtain a calf at this age, it may be necessary to select it at weaning time or even after it is weaned, but the best time, as stated, is before weaning.

Calves are frequently classified at fairs and calf shows as "senior" and "junior" calves, depending upon the time of year they were dropped. A calf, for instance, that was dropped between September 1 and December 31 the year previous to the show would be classed as a "senior" calf, and one dropped between January 1 and August 31 previous to the show, a "junior" calf. As a rule, a fall or senior calf, on account of its age at the usual time of holding the show, is to be preferred, although there are advantages in selecting a spring or junior calf, especially one dropped in January or not later than February. This, however, depends upon the rules of the contest at which the calf is to be shown and upon the facilities at hand for feeding and caring for it.

THE KIND OF CALF TO SELECT.

Choose a calf of the breed that you admire most and believe suited to your conditions, provided the community in which you live has not already adopted some other breed. You should cooperate with your neighbors in developing one breed for your community. You will also obtain much valuable information about calves by working and advising with others, especially those who have had more experience. Select a good purebred calf. It is not sufficient that it be

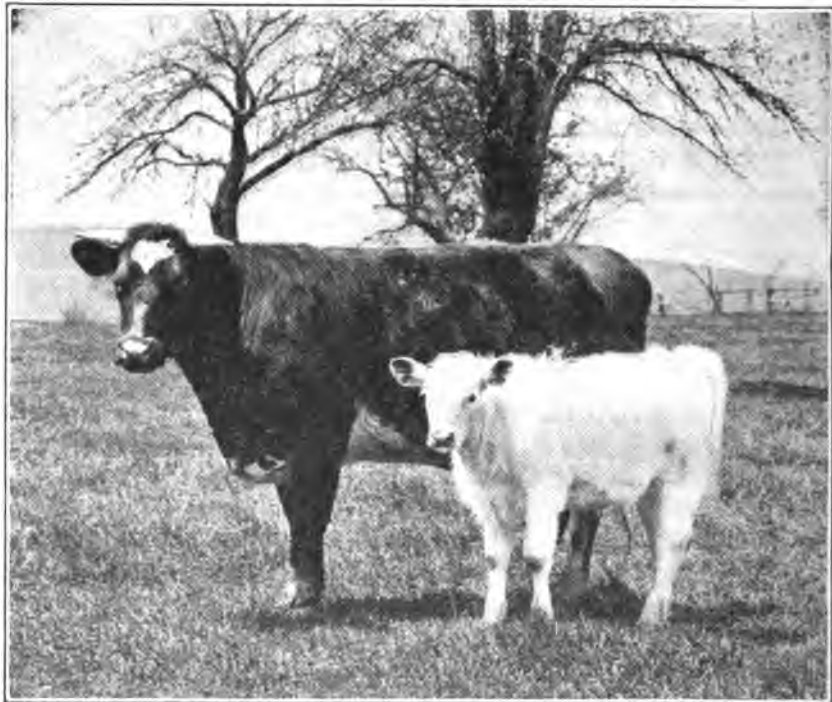


FIG. 1.—Select the calf if possible when it may be seen with its mother.

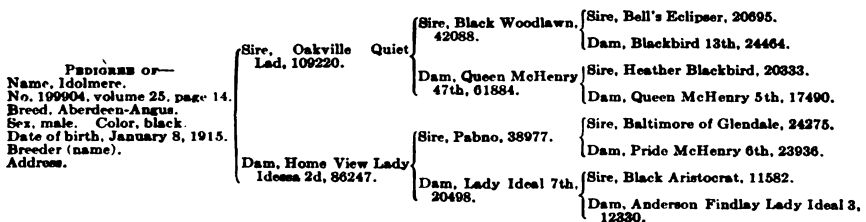
a purebred. It should be registered, as shown by the registration certificate furnished you by the breeder and signed by the secretary of the national association representing the breed.

In addition to being a good individual it should have good breeding back of it. Its parents, grandparents, and so on, should have been useful and profitable to their owners. These facts may be learned from a study of the calf's pedigree. To know a good pedigree when you see it will require some study on your part. Read a history of your chosen breed. Become familiar with individuals and bloodlines which have been instrumental in building up the breed. Such information may be obtained from books sold by publishing

houses, from livestock journals, or from free bulletins issued by your State college of agriculture or by the United States Department of Agriculture. Much valuable information may be obtained also from the secretary of the registry association of the breed you select. The State association organized in the interest of your favorite breed will be able to assist you materially. Join such an association at your first opportunity.

Subscribe for a good livestock paper, especially the official journal published by the registry association of the breed chosen. Study the advertising section. Much can be learned from the announcements of sales and auctions in regard to popular pedigrees. Examine carefully the pictures of the breed's best specimens. Become familiar with the names of the breed's noted individuals, both past and present, and look for them in a pedigree.

Attend public sales held by breeders. Study sale catalogues and note the remarks made with reference to the breeding of different animals. An appreciation of the esteem in which the breeders hold bloodlines of different individuals may be gained by noting the prices paid and the activity of the bidding on them. A word of caution here, however, may be necessary. Breeders frequently become over-enthusiastic on family bloodlines regardless of how distant they may be. In analyzing a pedigree consider carefully the sire, grandsires, and great-grandsires, or parents in the first three generations, for they contribute seven-eighths of the heredity. Look for the names of famous individuals in these first three generations. Back of them the breeding should be consistent, without undesirable outcrosses. Of course the females in the pedigree must not be overlooked, but it is the bulls that determine its value to a great extent. Look for the names of noted men as being the breeders of some of these animals. Remember that a breeder becomes famous by having produced noted animals. The following is a sample pedigree showing the first three generations:



In every breed there are certain bloodlines that are known to "nick" well with another one. Ascertain what "nicks" or crosses have produced the best results, and look for these combinations in a pedigree. Do not be misled by family names, which in some cases are derived from a female that appears as far back as the twelfth to

the fifteenth generation. Such a pedigree would carry less than one-tenth of 1 per cent of the bloodlines of this famous cow and still the animal it represents would be known as a member of the family of which this cow was the foundation. Thus it is evident that in using family names derived from the female the influence of many good bulls is wholly disregarded. Cattle breeders are fast losing sight of the family connections on the female side and are beginning to place more credit where it rightfully belongs, that is, with the bulls that appear in the first two or three generations which are entitled to recognition through performance in the show ring and breeding herd.

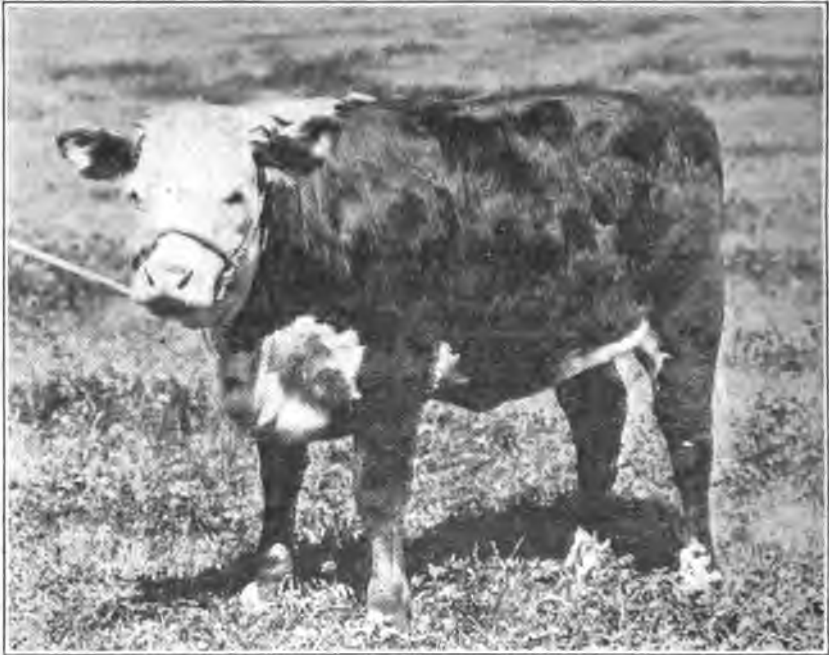


FIG. 2.—A calf of desirable type. Note the beef conformation and the excellent breed characteristics shown in this heifer.

SELECTING THE CALF.

If the calf selected is to develop into a useful, profitable individual for breeding purposes, it must be a good calf as well as the descendant of good ancestors. To be classed as a good calf it must have the proper form, which is sometimes spoken of as "type" or "conformation." If you expect to select a calf with these necessary requirements, you should become familiar with them. Study pictures of famous animals; note their form. A score card of the breed you are most interested in would be useful. Learn the different parts of a beef animal and the method of examination in judging them.

In selecting the calf, first get an idea of its general appearance. This you may do by looking at it from a distance of from 10 to 15 feet, observing its weight or growth according to age, conformation, quality, condition, body, breed type, and general disposition. Observe it closely, beginning at the head and neck, then forequarters, body, and hind quarters, in order named. Keep in mind that you are either selecting a calf for a herd bull or for a foundation breeding cow. If a bull is selected, it should not have the appearance of a heifer or a steer, but the strong, vigorous, masculine appearance of

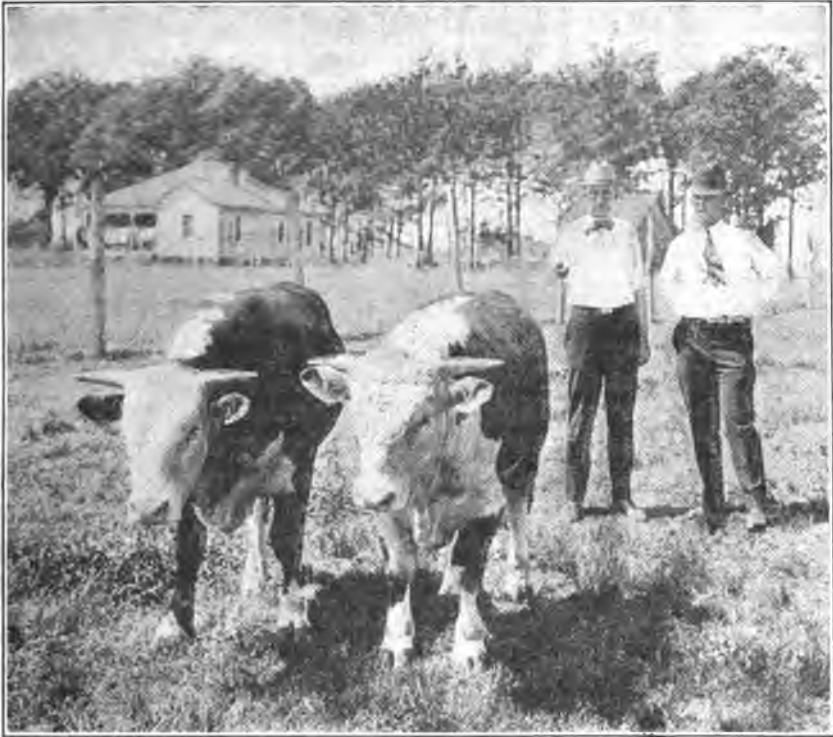


FIG. 3.—Selecting the calf for breeding purposes. It can easily be seen which of the two calves is being chosen.

a bull in every detail. If a heifer is selected, she should have the feminine appearance of a good breeding cow rather than the possible coarseness or roughness of a steer.

Thus observing the calf without putting your hands on it, select one that is stylish and active. When viewed from the front it should have a short face, large muzzle, wide forehead, short neck, and a wide, deep chest, indicating a strong, vigorous constitution. When looked at from the side its back should be straight and level from top of shoulders to the tail. It should have a deep body and smooth,

long hind quarters. When viewed from the rear it should present a wide, deep appearance. While as much width as possible is desired, it should not be accompanied with roughness about the shoulders and the hips or hocks. The legs should be rather short, stout, and set wide apart. A calf that stands high from the ground, cut up in the flank, and shallow in the heart girth, has little chance of developing into a useful or profitable breeding animal.

After you have found a calf with good general appearance, have some one hold it so that you can put your hands on it. This is the best way to determine what are called "condition" and "quality." Condition means the amount of flesh and fat the calf has. Select a calf in good growing condition but not excessively fat. The beef calf for breeding purposes should have great depth of natural flesh and be free from roughness or coarseness in any way. By running the open hand along the back and sides with a slight pressure of the finger tips the amount and quality of condition may be determined. A calf in proper growing condition, while not possessing the depth of flesh of a mature animal, should have a smooth, even covering of firm though not hard flesh along its back and sides and over the shoulders.

Quality may be determined by the eye of the experienced judge, but the hand may also be used to advantage. All the following indicate quality: A thick coat of hair that feels soft and silky and looks glossy; a loose, pliable skin that does not seem thick, rough, or tightly stretched over the body; and rather short legs that appear to have strong, clean bones without roughness or coarseness.

A calf showing early maturity, as indicated by the tendency to put on an even covering of rather firm flesh, is desirable, and should be selected if possible.

Color is of little importance so long as the calf selected has the approved color of the breed desired. There are, however, popular shades and color markings of the different breeds, which you will learn from further study of the breed selected.

EQUIPMENT NEEDED FOR GROWING THE CALF.

The necessary equipment to feed and care for the calf properly should be provided. This equipment need not be expensive, but it should be convenient. The barn or shed in which it is kept should be cool in summer and dry in winter. An especially warm barn is not necessary, but cold winds and rain must be kept out.

The fences around the pasture where the calf grazes should be kept in good repair. Do not teach the calf to jump or be a rogue by allowing it to run at large or to go through or over poor fences. It is better to have a gate for it to walk through than bars to jump over.

The calf may graze with other cattle on pasture, but should be fed grain separately. A bull calf should be separated from the heifers

at about 3 or 4 months of age. He should be kept with other bull calves or older cattle for company except at feeding time. The calf should then have a separate stall or pen. The stall or pen should be so arranged that the calf may see other calves or cattle to keep it from fretting when alone.

The stall should be kept clean and dry at all times. If the ground in or about the stall is low and wet, broken stone should be used to raise it to keep it dry. Small stones or gravel or preferably clay should be put on top and firmly packed down. Use plenty of straw, leaves, shavings, or other litter for bedding, so that the calf may be induced to lie down a large part of the time. A calf will not thrive and do well if made to sleep on a damp, foul-smelling bed. If the



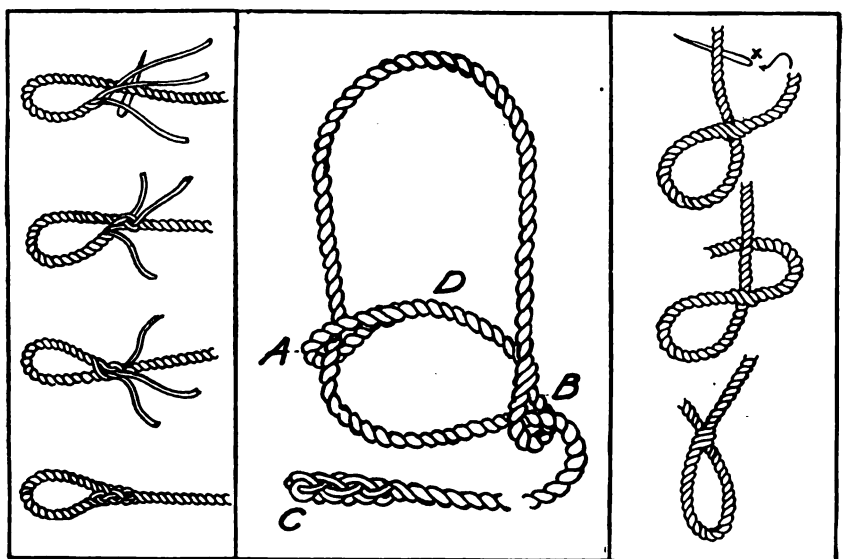
FIG. 4.—A round-up of beef calves at a county calf-club show.

lot where the calf takes its exercise in winter is wet and muddy, the water should be drained off through ditches or otherwise disposed of.

The feed manger for the hay and silage should be convenient and large enough to hold all the feed given, so that it will not be crowded out and wasted. The manger should have a tight bottom to hold the small particles of hay, especially the leaves, as they are the most valuable part. The feed box for grain needs to have a tight bottom and be large enough to prevent loss while the calf is eating. If some of the feed is lost, the cost of gains in weight will be greatly increased. The appearance of the calf usually reflects any negligence on the part of the owner.

If the calf is watered from a trough or a stream, the place should be kept clean. Do not allow mud to accumulate about the approach to it. The overflow water from the trough should be drained to

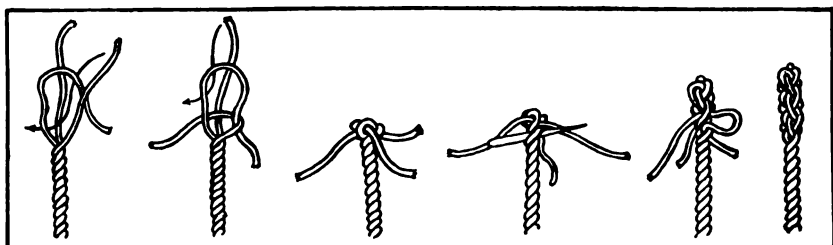
one side. Broken stone may also be used about the trough or the entrance to the stream to keep it free from mud and attractive, so that the calf will want to drink an abundance of water. If a pond or a spring is used, do not allow the calf to stand in it, as that will dirty the water. Diseases of the feet may also be contracted about



Steps in making eye loop, A.

Completed halter. A, eye loop; B, loop splice; C, crown knot; D, nose piece.

Steps in making loop splice, B.



Steps in making crown knot, C.

FIG. 5.—A completed rope halter, and steps showing method of making. A marlin-spike is used to separate the strands. The eye splice should be just large enough to allow the rope to pass freely through it. The loop splice should be far enough from the eye splice to form the nose piece. A more detailed description will be given upon application.

dirty watering places. If the calf is watered from a well or a spring by a bucket, provide one especially for that purpose. Do not use the bucket for any other purpose or any other animal.

A bin or box for storing the grain should be provided. It should hold the grain supply for several weeks as mixed and weighed up. Keep the box in a dry, convenient place. It should have a hinged

lid that will close tight to keep out chickens, rats, and other animals. Arrange in a convenient place a small box in which to keep salt at all times.

A fork will be needed to keep the stall clean and to handle hay or other roughages. A large basket without a handle will be convenient to use in weighing and feeding the silage.

Other items of equipment needed in caring for the calf are curry-comb, brush, coarse-tooth comb, burlap blanket, halter, and clippers or shears for trimming hair. A very strong, cheap, and serviceable halter, one which every boy should be able to make, is shown in figure 5. To make the halter use from 12 to 14 feet of $\frac{3}{8}$ -inch manila rope; sharpen a hardwood stick, called a "marlinspike," as illustrated, to separate the strands. The different steps in making the halter are shown in the figure.

KEEPING THE CALF HEALTHY.

Most calf ailments are due to improper feeding or insanitary conditions, or both. Keep the calf out of cold rains in winter as much as possible, and provide a dry, well-bedded stall at night. Provide nature's tonics—exercise, sunshine, pure air, abundance of fresh water, and a variety of feeds, and there will be little need for medical attention. It is not for the purpose of curing diseases that these suggestions are offered, but to prevent their occurrence. Observe the calf closely at all times. If it should appear drowsy, feverish, stiff, or sluggish, act quickly. Reduce feed at once and the disorder may be in a large measure prevented. Keep salt before the calf at all times. An abundant supply of fresh water should be available always. Some of the commoner ailments only are briefly discussed here, with a few suggestions for first-aid treatment. In case of serious illness consult a competent veterinarian at once. Do not delay.

Constipation.—Occasionally when the newborn calf fails to get the colostrum or first milk from the cow its bowels remain inactive, and the meconium (first droppings) are retained, which causes constipation. An enema or injection of 1 quart of warm water in which 1 teaspoonful of common baking soda or one-half teaspoonful of common salt has been dissolved will usually give relief. Use a syringe or allow the solution to gravitate through a small rubber hose or funnel. Two tablespoonfuls of castor oil may be given, and repeated if necessary.

The solid droppings of an older calf should be observed daily. If they appear extremely solid, the animal is constipated or feverish. With older calves this condition may be relieved in most cases by promptly providing plenty of water, by reducing the grain and dry roughage and substituting a more laxative ration. A small

quantity of linseed-oil meal, wheat bran, and legume hay, such as alfalfa, soy bean, or lespedeza, may be used. If this does not relieve the condition, give castor oil or raw linseed oil, one-fourth pint, or Epsom salt in doses according to the age of the calf, although dosing should be avoided as much as possible.

Diarrhea or "Scours."—If constipation is not relieved diarrhea or scours may follow. This ailment is indicated by thin, washy, offensive droppings. It is usually the result of improper feeding, irregular suckling, or overfeeding with anything that overloads the stomach. Damaged grain fed to the calf, or even to the cow before the calf is weaned, may cause digestive disorders. Exposure or overheating may also be a predisposing cause. Silage, alfalfa hay, and possibly linseed-oil meal, when fed in large quantities to older calves for a long period, may cause this condition, which should be corrected by an immediate reduction of such feeds and the substitution of dry grass hays and a little cottonseed meal for a part of the ration. If such conditions occur with a calf not yet weaned, reduce the milk allowance and withhold all grain. In severe cases withhold all feed for 12 hours. As a last resort put the cow on dry feed entirely and let the calf suck another cow.

Remedies easily obtained for the small calf are castor oil, 1 tablespoonful to one-fourth pint, depending upon the size of the calf, given as a drench with warm, sweet milk, followed by 1 teaspoonful of a mixture of 1 part salol and 2 parts subnitrate of bismuth. Another remedy used with success is 4 drops of formalin to 1 quart of warm milk. Commonly used home remedies include whites of 2 raw eggs or a weak solution of limewater given in 1 or 2 tablespoonful doses. Feed and manage the calf so as to prevent diarrhea or scours. Such disorders stop the growth of the calf for several days at least and make it more susceptible to them later.

Blackleg.—Blackleg is an infectious disease associated with external swelling, usually about the forelegs or shoulders, and which emits a crackling sound where handled. The germ causing the disease is widely distributed throughout most sections of the country. Young cattle between 6 months and 2 years of age are most likely to take the disease. Calves under 6 months old are rarely attacked. Blackleg is controlled by immunization by vaccination. All animals should be vaccinated before they are 6 months old and again 6 months later. Vaccine can be obtained from the United States Department of Agriculture, Bureau of Animal Industry, Washington, D. C., from your State college or State department of agriculture, or from companies manufacturing the serum.

Lice.—It is not a reflection on the owner for his calf to have lice on it, but to allow them to remain there is a serious reflection. They not only annoy the calf but lower its vitality to resist diseases and

disorders, and prevent normal growth. The hair of a calf infested with lice is usually rough, stands on end, and lacks the glossy appearance of the coat of a healthy, well-fed calf. The calf may become infested with two kinds of lice—blue and red. The one sucks, the other bites the skin. If a calf becomes infested with lice they should be removed at once. This may be done by dipping early in the spring or fall. As the lice reproduce from eggs, a second dipping in each case, from 10 to 14 days after the first, is recommended.

Since but few dipping vats are available in most sections, it will be necessary to wash or spray the calf thoroughly with some good coal-tar, tobacco, or oil-emulsion dip prepared for the purpose. A

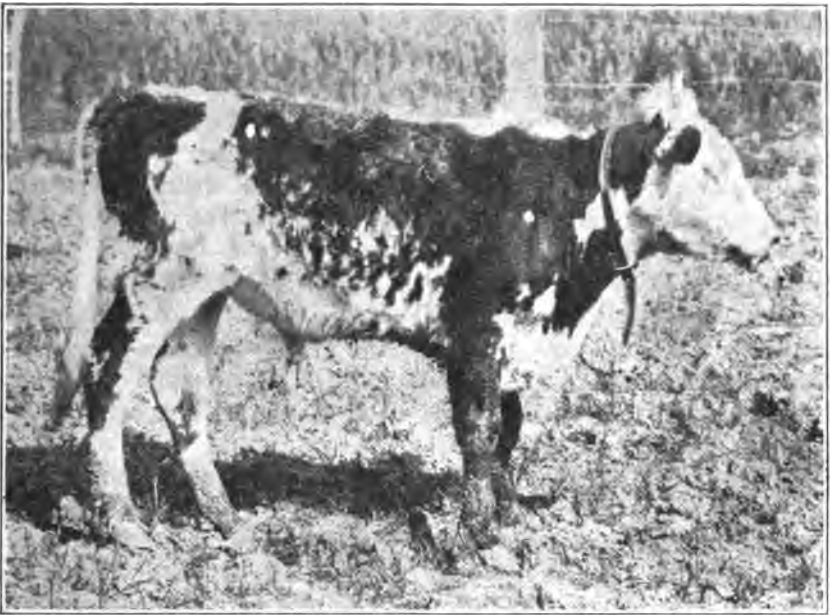


FIG. 6.—A lousy, mangy calf. A calf to make the best growth must be free from lice and parasitic pests.

home remedy frequently used is a mixture of one-half pint of kerosene and 1 pound of lard, applied by thoroughly rubbing into the hair, especially about the neck and shoulders. This remedy, like dipping or washing, is not advisable for small calves in cold, wet weather. An effective powder which may be used any time is prepared as follows: Mix gasoline 3 parts, carbolic acid 1 part, and plaster of Paris enough to take up the liquids. Make a paste and allow to dry. Powder and shake into the hair thoroughly from a shaker or duster. (CAUTION: *Do not mix near a fire.*)

Mange.—Small mites which attack the skin and cause it to become thickened and covered with crusts and scabs greatly annoy the calf

and cause it to rub or lick itself constantly with consequent loss of hair about the tail, neck, and shoulders. The mites multiply rapidly and are spread from a diseased to a healthy calf by the animals running together or occupying the same stall or pen.

The treatment is to dip or wash the calf the same as for lice, with a lime-and-sulphur, tobacco, or oil-emulsion dip. A mangy calf, like a lousy one, never makes satisfactory gains nor a creditable showing. The hair is usually rough and the skin thick and coarse, which gives the calf an appearance of one lacking vigor and general thrift.

FEEDS FOR THE CALF.

The beef calf is able to use to advantage many coarse, cheap feeds produced on the farm. It is a mistake, however, to think that a prize winner or the most profitable breeding animal can be grown on pasture, stover, or hay alone, for such is not the case.

Feeds which the calf should have are divided into two groups. One is called "concentrates," the other "roughages." The concentrates include either whole or ground grains and their by-products, such as corn, oats, barley, velvet beans, rye, milo, kafir, bran, cottonseed meal, cottonseed cake, peanut meal, and linseed-oil meal. Roughages are of two kinds, dry roughages, such as hay, stover, and straw, and succulent roughages, which include silage and root crops. Pasture grasses or plants such as blue grass, Bermuda, lespedeza, clover, alfalfa, and prairie grass are classed as succulent roughages, also winter pasture, which may be obtained by grazing oats, wheat, soy beans, cowpeas, velvet beans, or other crops.

All feedstuffs used should be clean and free from mold, mustiness, or any condition that would make them unpalatable or possibly disturb the digestive system of the calf.

Special kinds of feeds or combinations of feeds are necessary for the proper growth and development of the calf. Some are best suited for the production of fat, some for the production of muscle, hair, and hide, while others should be used for the growth of the bones or framework of the body. Different feeds, therefore, have different values and functions for calf feeding. Unless the calf owner has already gained from study and experience a knowledge of the use and value of different feeds he should learn these things, at least in a general way, in order to be able to feed most successfully and cheaply. This is especially true of concentrates. A better idea of their use and value for different purposes may be formed by dividing them according to, first, their protein content, and, second, their carbohydrate and fat content. Most feeds contain protein, carbohydrates, and fats, but many are deficient in some one of these important compounds and for this reason are given special consideration.

Protein is part of the feed which when eaten by the calf goes to make lean meat, hair, and hide. Carbohydrates and fats, while different in character and value, are both used for the formation of fat, and for this reason are spoken of or classed together as carbohydrates. Those concentrates which are high in carbohydrates and fats usually contain little protein. Mineral matter, used in the formation of bones, lean meat, and blood, is also a very essential part of feeds. A sufficient amount is usually present in most feeds, especially if legume hays and a variety of concentrates are fed; so it is not further considered.

In many instances legume hay, such as clover, alfalfa, and lespe-deza, which contain a large proportion of protein, are used to supply a large part of the protein needed in the ration. Hays and roughages in general, both dry and succulent, should also be used in a ration, for the reason that they keep the animal's digestive system in a good, healthy condition. In a general way, feeds, both concentrates and roughages, are classified according to their protein and carbohydrate value, as follows:

Protein Feeds.

CONCENTRATES.

Cottonseed meal.
Linseed-oil meal.
Velvet beans.
Peanut meal.
Soy beans.

ROUGHAGES.

Alfalfa hay.
Clover hay.
Lespedeza.
Velvet beans.
Legume forage.

Carbohydrate Feeds.

CONCENTRATES.

Corn.
Oats.
Barley.
Kafr.
Rye.
Milo.
Feterita.

ROUGHAGES.

Grass hays (timothy, Johnson grass, prairie, etc.).
Straws (wheat, oat, etc.).
Corn or sorghum stover.
Corn or sorghum silage.
Roots.
Cottonseed hulls.

In making up a ration (feeds for one day) for the calf it is always advisable to use at least one kind of feed containing a large amount of protein and two or more containing carbohydrates, such as corn, oats, or barley. When feeds from the two groups are used, both of the important nutrients are provided. A ration which thus contains the proper quantity of both protein and carbohydrates is called "a balanced ration" and should always be fed when possible.

FEEDING THE CALF TO WEANING TIME.

The feeding of the calf from birth until it is weaned is a very simple matter if its mother gives milk enough to nourish it properly. The principal part of the calf's ration, therefore, may be cheaply and safely provided by giving its mother the proper feeds for the

production of milk. Do not feed the cow too heavily on grain soon after she has dropped the calf. While it is important that the calf have plenty of milk at all times, it should never have too much, especially soon after birth.

A calf dropped in the fall or winter probably will do better if kept separated from its mother and allowed to suck night and morning. In summer it should be provided with a lot for exercise and pasture in the daytime, and during the winter with a well-bedded box stall at night. When the calf is from 4 to 6 weeks old it is a good plan to bring it from the lot early in the morning, allow it to suck, then take it to the pen or stall to be fed some grain. It should also be suckled at night before grain is fed, then taken out to the grass lot or be fed a little hay in the stall. To keep a calf contented when away from its mother, it should run with other calves. A bull calf should be separated from the heifers at the age of 3 or 4 months. If the calf is dropped late in winter or spring it may be more convenient to allow it to run with its dam for several months on pasture.

Since milk is nature's food for the calf it would be reasonable to suppose that milk alone is sufficient feed for it. In all cases, however, it should be provided with a little grain in addition to milk. If both the cow and the calf have good pasture and the cow is giving milk enough, the calf will grow to weaning age in good condition with less grain than otherwise would be needed. Frequently, however, the amounts of both pasture and milk are somewhat limited. Then the feeding of more grain is absolutely essential for best results.

When from 4 to 6 weeks old a calf may be taught to eat grain. This may be done by feeding it in a creep or pen to which the cow does not have access. Wheat bran is an excellent feed for this purpose. A good ration for the first few weeks would be coarsely ground corn, oats, and wheat bran, equal parts by weight, with a small quantity of oil meal added every few days. Feed the calf at first one-fourth of a pound of grain a day, or just what it will eat up clean, giving one-half of the amount night and morning. After a few weeks a ration of whole oats 4 parts, shelled corn 2 parts, and oil meal 1 part by weight should be substituted for the ground feeds. The calf should be eating from 2 to 3 pounds of grain a day when 6 months old, or approximately one-half to 1 pound of grain per 100 pounds live weight.

Unless the cow has been giving sufficient milk previous to this age of the calf, it may be advisable to provide a nurse cow for the calf. To make the most satisfactory growth the calf should have a liberal supply of milk for several months longer. This is especially true if it is to make a maximum growth and show to the best advantage when the fair season arrives. By being fed in the way de-

scribed, it should make a continuous growth from birth. If weaned properly, so that none of the calf fat or bloom is lost, the chances for it to grow out and make a profitable and useful animal are decidedly in its favor.

The calf is old enough to wean when from 8 to 12 months old. Weaning should take from 12 to 15 days, and should be done gradually. When old enough to wean allow it to suck once a day for a week, then every other day for four or five days, and increase the interval until no milk at all is allowed.

FEEDING FROM WEANING TO MATURITY.

The feed, care, and management which the calf should receive after it is weaned will depend largely on the time of year it was dropped. A spring calf should be fed differently from one dropped in the fall. It is assumed that in either case, however, the principal part of the calf's feed for the first few months was its mother's milk. In addition to the milk it should have been fed grain so that at weaning time it would be getting from 2 to 6 pounds, depending upon the age of the calf and time of year when weaned, with a little silage and a liberal amount of hay as well.

If the calf has not been taught to eat grain before it was weaned it should be taught at once. Begin by feeding it as recommended for the calf before weaning. The amount of feed, however, may be increased more rapidly than with the unweaned calf. In a month or six weeks after it is weaned it should be eating from 2 to 3 pounds of grain with 6 pounds of silage and from 2 to 3 pounds of clover hay, with a small amount of other roughages like stover or straw in addition, unless sufficient pasture is available.

A standard grain ration for the calf may be made by using corn, oats, and bran, equal parts by weight, or corn 5 parts and oats or bran 3 parts by weight, with 1 part of linseed-oil meal added to both unless the ration seems too laxative. It is expected that in many cases all these feeds will not be available. It will be necessary then to substitute other feeds. The following substitutions are recommended:

Feed.	Substitutes.
Corn-----	Barley, kafir, milo, oats, or other foods high in carbohydrates and fats.
Oats-----	Bran, ground oats, coarse middlings.
Bran-----	Ground oats, coarse middlings.
Cottonseed meal----	Cottonseed cake, linseed-oil meal, peanut meal, velvet-bean feed, soy-bean meal, or other feeds high in protein.
Corn silage-----	Sorghum silage, other silage, roots or mangels.
Clover hay-----	Alfalfa, lespedeza, peanut vine, soy-bean, or grass hays.
Corn stover-----	Oat straw, other straws or stovers.

The quantity of grain to feed should be determined at all times by the appetite of the calf. Feed what it will clean up in a short time and wish it had just a little more. A variety of hays should be provided if possible. While the beef calf can use cheap roughages to advantage, good hays, preferably legumes, such as clover, alfalfa, and lespedeza, are more satisfactory. Well-cured, bright, corn stover or oat straw may be used to supply a part of the roughage needed and keep the calf's appetite good and its digestion in proper order. Give as much hay as it will consume, but do not allow any waste. If the calf is on good pasture it will not consume much hay. As it increases in age it can be fed silage to advantage. Avoid overfeeding with silage, as there is danger of digestive disturbances, especially when getting a liberal supply of milk.

Pasture should be provided at all times. Next to milk it is nature's balanced ration. Sufficient pasture may be obtained from such pasture plants as blue grass, Bermuda, lespedeza, carpet grass, clover, alfalfa, and prairie grass. Late fall, winter, or early spring pasture may also be obtained by grazing such crops as rye, oats, wheat, soy beans, cowpeas, and velvet beans. Use great care in pasturing legumes, such as alfalfa and the clovers, also winter pasture crops. Turn the calf on such crops for only a short time at first, because the calf may bloat from overeating on such feeds. After it becomes used to them it may graze with safety.

RULES OF FEEDING.

There are many things to remember in feeding the calf. They may be called rules of feeding and should be carefully followed.

1. **Provide a variety of feeds** at all times, if possible. It is easier to supply the proper amounts of the desired nutrients which the calf needs, if several different feeds are used. The ration will also be more palatable.

2. **Do not make sudden changes** in the feeds used or in the amounts given. If it becomes necessary to change feeds from, say, clover to alfalfa hay, feed part clover and part alfalfa for a few days. Gradually reduce the amount of clover and at the same time increase the alfalfa.

3. **Do not overfeed the calf.**—Feed as much grain as it will clean up in 30 minutes and wish it had just a little more. Feed left in the trough to be breathed over is worse than wasted. If any remains it should be removed and less given the next time. Digestive disorders occur from feeding too much rather than too little.

4. **Do not underfeed the calf.**—It should make a continuous gain. If it does not grow each day the feed given it is about the same as wasted. It never pays to starve a calf. In fact, the calf does not begin to pay for feed until it is given more than enough to make some gain.

5. **Do not annoy or disturb the calf unnecessarily.**—The fattening or growing calf should be kept as quiet as possible. It requires more feed to keep it growing while standing or moving about than while lying down at rest.

6. **Do not feed moldy, musty, or spoiled feeds.**—To do so may cause serious digestive disorders. All hays should be bright, well cured, and free from mustiness, dirt, and coarse weeds. The grain also should be free from dirt, mold, and mustiness. If ground feeds get wet they are likely to mold. This is especially true of cottonseed meal and ground corn. They should not be fed if in bad condition.

7. **Do not waste time in feeding the calf.**—To waste time in feeding or preparing feeds needlessly increases the cost of gains. Grain should be fed whole except when teaching the calf to eat and possibly also near the end of the fitting or finishing period. Whole grain as a rule is more palatable than ground feeds. Ear corn may be shelled, broken, or chopped up in the feed box rather than ground. Husks on snapped corn need not be removed for this purpose. It rarely pays to shred stover or to cut or chaff hay for the calf. It need not be fed three times a day when twice a day will do as well, although the former may be practiced when fitting the animal for show or sale. Do not go to the expense of buying prepared "stock feeds" or "remedies." Home-mixed feeds are cheaper and equally, if not more, satisfactory. A healthy calf does not need condition powders.

PREPARING FOR SHOW OR SALE.

When a well-fed and properly developed calf is brought into the show or sale ring it should present a pleasing appearance. In order to do this it should be clean, well-groomed, halterbroken, and trained. To train a calf, put a halter on it and teach it to lead and to stand squarely on all four feet with head alert so as to exhibit its best features. It should become accustomed to being handled by strangers, seeing strange sights, and hearing unusual sounds, such as it will see and hear at the show or sale. A good calf is frequently placed below an inferior one because the judge can not put his hand on it to judge it correctly. The trained animal that stands correctly and "poses," so to speak, has the advantage over one that flinches, kicks, pulls on the halter, and stands with its feet in such position as to give the appearance of a weak back, narrow chest, and poorly developed rump.

For a few months before the show the calf may be fed three times a day with good results. Some feeders use molasses, chopped feeds, and wet mashes. As a rule, however, more satisfactory results will be obtained from using a good combination of the common feeds produced on the farm. The healthy, normal calf will make sufficient gains and have a desirable finish with such feeds without coaxing or tempting its appetite.

The calf should be kept in a cool barn during the day and allowed to graze at night for a few months previous to the show. The hot sun from June to September will "sunburn" the hair and cause it to appear somewhat dead, rough, and coarse, and to lose its glossy appearance. Burlap bags suspended by wires from above for the calf to brush against may be used to advantage to repel the flies which greatly annoy a calf. The stable also may be darkened and many flies kept out by tacking burlap sacks over the windows and doors. If in the pasture, the calf should have plenty of shade.

A few weeks before the show the calf may be blanketed to advantage. The blanket, which is usually made of burlap, is used mainly to keep flies from worrying the calf, to give the hair a more glossy appearance, and to help mellow or soften the hide. The burlap used for this purpose should extend from the neck to the tail and come down over the sides.

When the calf is taken from its stall before the judge at the show, it should be clean and carefully groomed. The use of sufficient bedding will help to keep it clean. Do not wait until time to bring your calf into the show or sale ring before cleaning it up, but begin several hours before the time announced for the class to appear. The calf should be washed every few days, and occasionally with warm water and tar soap. Make a good suds in the water and then add more soap to the hair. Rub and work the hair with the hand or brush until all dirt is worked loose. Wash the suds and dirt out with cold water. Frequent washing keeps the animal clean, stimulates a heavy growth of hair, and makes it loose and fluffy.

The calf should be groomed or thoroughly brushed each day for several weeks before the show. Brushing lengthwise of the body with considerable pressure will help work the hide loose and pliable and gradually remove the old hair. The final brushing on a short-haired calf should be in the same direction as the hair, the hand each time following the brush. The hand will draw the oil to the tip of the hair. A woolen cloth may be used to advantage in removing the dust and the dirt. The final brushing for the long-haired breeds (Shorthorn, Hereford, Galloway) should be opposite to the direction of the hair to make it loose and fluffy. Short-haired animals (Aberdeen-Angus, also Red Polled, and Devon) are shown with the hair smooth. Animals with long hair are shown with the hair curled.

An hour or two before the calf is to be shown moisten the hair with a mixture of creosote dip and soapy water. Do not make the hair too wet or it will appear in locks instead of loose and fluffy. The hair on the center of the back should be parted with a coarse comb along the backbone in one straight line from the neck in front of the shoulder to the tail. Comb the hair on each side at right angles or straight out from the center parting to the extreme edge of the flat portion of the back. Mark the hair with the comb or brush



FIG. 7.—The hair is first parted along the back before curling.



FIG. 8.—Making the parallel lines along the sides to curl the hair.



FIG. 9.—Brushing up the tips of the hair to give the fluffy, wavy appearance.

from in front of the shoulders to the tail or extreme back of the round. The lines should be on the outer edge of the flat portion of the back so the end of the hair will curl up even with the level portion of the back and make the back appear wide. The lines should be about $1\frac{1}{4}$ inches apart, distance depending upon the size of the

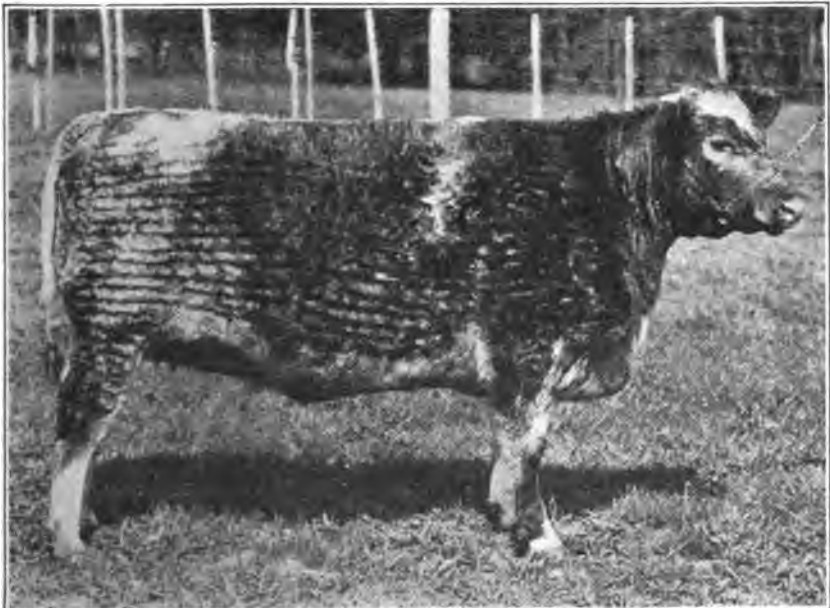


FIG. 10.—A properly fitted Shorthorn, showing the wavy appearance of the long hair.



FIG. 11.—The round comb may be used to curl the hair of the Hereford.



FIG. 12.—Catching the tips of the hair or combing up to give the wavy appearance.

calf, and parallel to the first line. After considerable experience the curling of the hair may be done with the currycomb alone. A round one is best for this purpose. After all the lines are made the hair that was combed back in making the marks should be lightly brushed up with a brush or currycomb. This will leave the hair in distinct wavy lines as desired. The hair on the flanks and defective places should be brushed up to fill them out. The Aberdeen-Angus is shown as illustrated in figure 15.



FIG. 13.—A Hereford with hair curled for the show ring.



FIG 14.—The Galloway is usually shown with the hair curled.

If the hair does not have the desired shiny or glossy finish, dampen a cloth with a mixture of equal parts of olive oil and denatured alcohol. Apply this lightly on the hair, following with the hand to give it a proper finish.



FIG. 15.—The Aberdeen-Angus is shown with the hair smooth and glossy.

Clip the long hair from the tails of all breeds a few weeks before the show or sale, also from the ears except the Galloway and in some cases the Aberdeen-Angus. Begin clipping above the switch of the tail even with the point where the fullness of the twist begins to fail, and up to the tail head, gradually tapering the tail off at the



FIG. 16.—Method of clipping the hair from the tail.

top so that it is not necessary to clip any hair off the rump. One of the main objects of clipping the tail is to show the fullness of the twist and the thickness or beefiness of the hind quarters. Your own judgment should determine the extreme points that will show these characteristics to the best advantage with each individual. Two or three weeks before the show clip the hair on the head of the Aber-

deen-Angus from a point just back of the jawbone and 3 or 4 inches back of the ears (see fig. 17). Do not cut the eyelashes or the hair on the nose.

The feet should be kept clean, free from soreness, and in trim. A calf can not stand or walk properly if the feet are sore or out of shape. If the toes are too long the hoof must first be trimmed by tapering the bottom properly from back to front, thus leveling the hoof. This can be done with a chisel or hoof clip-pers. The hoof may be smoothed off with a file or rasp and polished with sandpaper or emery dust and oil. A mixture of oil and lampblack makes a suitable hoof polish. The feet of calves that stand in the stable, especially if not kept clean and well bedded and given frequent exercise, may become tender or even sore and diseased. The calf in such cases may walk lame, which is to its disadvantage. Sore or tender feet may be prevented by frequent exercise on the ground, clean quarters, and properly trimmed hoofs.



FIG. 17.—The head of the Aberdeen-Angus is clipped in front of the line shown, which may also include the ears. The eyelashes should not be clipped.



FIG. 18.—Note that properly (left) and improperly shaped horns (right) make considerable difference in the appearance of the animal.

On the horned breeds a well-curved set of horns commands the admiration of the judges and the consideration of the buyers. (See fig. 18.) The plain-headed animal of the horned breeds or one with poorly shaped horns will be at a disadvantage in the show ring and discounted by the individual buyer unless the horns have the proper shape. A symmetrical, properly curved set of horns can be obtained by the use of either weights or trainers, each of which has its advantages and disadvantages. (See fig. 19.)

As soon as the horns are long enough and sufficiently strong to bear the weight, it is time to begin with a light one. Use care to see that they are not put on while the horns are too young and soft. If the horns yield too quickly it is better to remove the weights and give the horns a rest of from 10 days to a month, depending upon the condition of the horns. Then replace the weights, until the de-

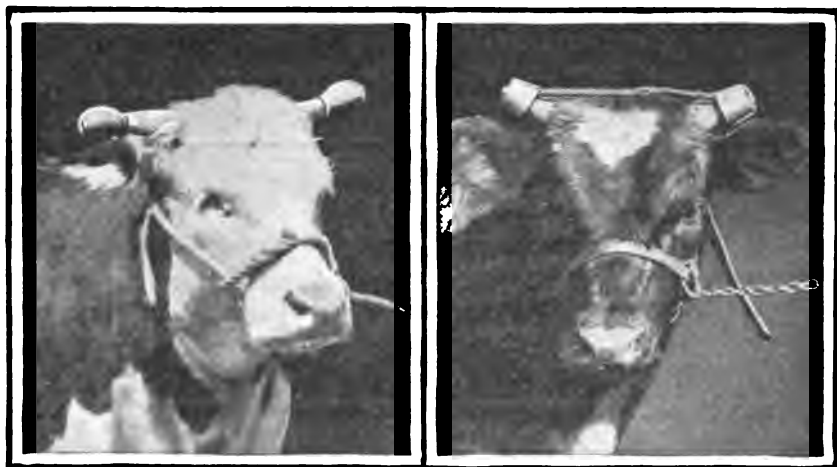


FIG. 19.—Different types of horn weights in position.

sired effect is obtained. When the horn gets below the level of the top of the head the direction of the ultimate growth will usually be decided. Skill in horn training is acquired by practice. The size of the weight to use can be determined only by study and experience.

The horn trainer, which is a mechanical device for drawing in and down the horns that stand out and up, should be applied while the horn is growing—as soon as it is seen that the horn is not developing properly. To attach, place the rings on the horns, being sure that each ring is the same distance from the head at the base of the horn. Fasten the straps securely and tighten the screw until it sets firmly in place on the horns. In some cases, when the horns have been neglected, it may be necessary to file one of the horns, as one may have grown larger in diameter than the other, preventing the rings from being a uniform distance from the base of the horns and making it impossible for the plate to lie flat on the animal's fore-

head. The horn trainer will need tightening from time to time, but never tighten it enough to cause it to strain. When the horns are growing as desired, remove the trainer.

A horn of medium size, neatly polished, is attractive and indicates quality. The rough surface should be smoothed first with

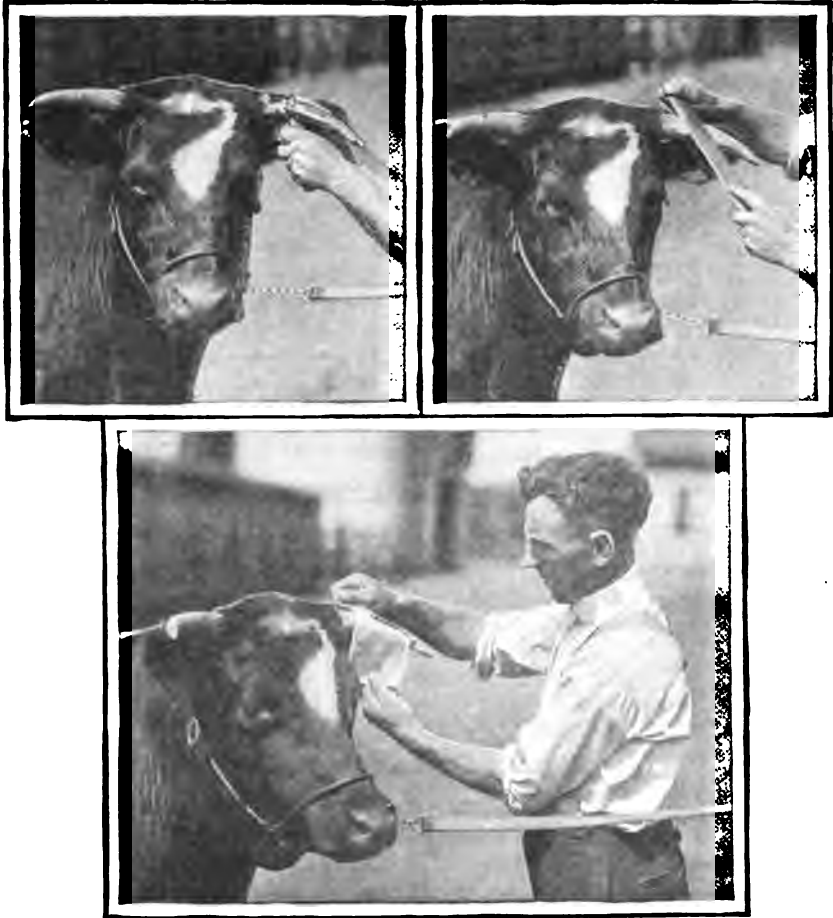


FIG. 20.—Polishing the horns. With a sharp knife first remove the rough, scaly portions of the horn, cutting toward the tip and using care not to cut too deep. The rasp is then used, filing on the upward stroke only, lifting it off the horn on the downward stroke. Finally, the smooth horn is polished with a woolen cloth moistened with linseed oil.

a sharp knife, then with a rasp or file, finished with fine emery paper or emery dust, and polished with a woolen cloth moistened with linseed oil. A polish also frequently used is sweet oil and tripoli. Sweet oil or cottonseed oil likewise may be used for this purpose.

The calf should be taken to the show or sale a day or more before the date set for it to begin. It should be taken on the train or hauled if the distance is more than a few miles. A fat calf not accustomed to walking on the road, seeing strange sights, and hearing strange noises may become greatly worried and fatigued from such a trip. Do not overheat the calf. Lead it quietly to the loading platform, if shipped by express or hauled in a wagon, and use a specially built crate (see fig. 21). If shipped in a crate or with



FIG. 21.—A shipping crate should be of a size suitable for the animal and securely put together.

other cattle in a box car, plenty of bedding should be provided. Feed the calf a little less just previous to and while on the trip, especially of grain and succulent roughages. When the calf gets to the fairground or sale pavilion it will then be eager for feed. Do not feed grain as soon as it arrives, but give it plenty of water and some hay until it has rested an hour or more from the trip.

While at the show give the calf plenty of exercise; take it for a walk about the grounds in the early morning. Remember that if you are to be successful in the show or sale ring you must pay close atten-

tion to your calf. Be kind, attentive, and faithful and you will be more liberally rewarded.

The show ring is the best school you have ever attended, provided you take decisions against you as well as for you cheerfully and try to find the reasons for them. There are usually good reasons, and they will help you greatly to be more successful at the next show or sale.

MARKETING OR BREEDING—WHICH?

After a good calf has been properly grown and developed, the question "What shall I do with it?" may arise. In most cases the young owners would no doubt prefer to keep the calf. This should

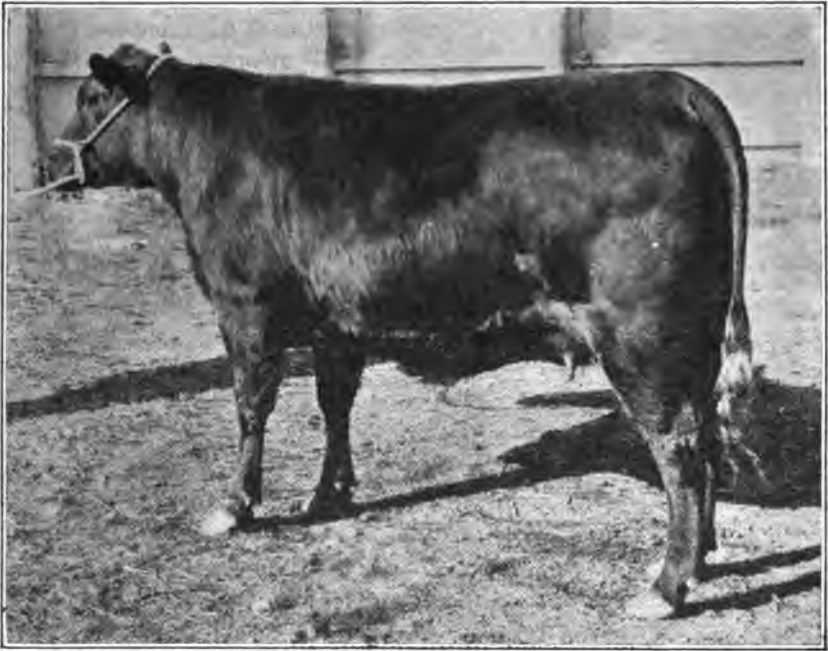


FIG. 22.—A bred heifer, properly grown, and in good condition to care for her calf.

be done, however, only after very careful consideration. It is assumed that the calf has had a good home, that it has been welcome at all times by other members of the family, and was brought up on a farm where feeds, pasture, and equipment for caring for it properly were always available. Would these be as cheerfully provided for the mature animal as for the calf? Above all, do you have the desire to become a breeder of purebred beef cattle? Do you get real pleasure and delight in working with them and serving them? If you do, and if the home farm is well suited to the business, you are probably justified in keeping the calf for breeding purposes.

If the calf is a heifer, she of course has to be fed and cared for so as to grow into a useful cow—one good enough to be the foundation

of your herd. It is important that she should have been grown, developed, and fitted for show in a way that will not limit or impair her usefulness as a breeder, whether kept by the owner or sold. Since there are so many calves that are underfed and improperly cared for, it does not seem necessary to caution against overfeeding or fitting the calf, yet it occasionally happens that the usefulness of a promising breeding animal is very materially lessened by the treatment it receives previous to breeding age.

A bull calf of desirable breeding and individuality may also be retained for breeding purposes on the home farm to advantage, although there are many reasons why a cow or heifer would be a better choice for the purpose.

A few suggestions as to the feeding and care of older animals are given, but the reader should get other publications giving more of the details if he has decided to become a breeder of purebred beef cattle.

FEED AND CARE OF THE BREEDING HEIFER.

It frequently happens that the purebred heifer is well cared for as a calf but when weaned is neglected and required to shift for herself with the rest of the herd. This is a great mistake. While it is especially desirable that she be fed cheaply, yet the heifer kept for breeding purposes should grow all the time and be maintained in a strong, vigorous condition. As she increases in age, cheaper and more bulky feeds may be used, but they should be fed liberally. Inferior breeding animals are largely responsible for "scrubs," although the empty feed rack adds many more to the list. A daily ration of from 15 to 20 pounds of silage, 4 or 5 pounds of legume hay, with a little other dry roughage like stover straw or cheap hays, the amount depending upon the age of the heifer, will be satisfactory and economical. Silage is especially desirable for the heifer, as in the case of other beef animals. If it is not available enough grain similar to that fed to the older calf should be provided, with sufficient roughages to make a satisfactory growth.

The heifer should be kept on pasture as much of the time as possible. If good pasture is available during the summer no other feed will be needed until late in the fall.

The heifer may be bred when about 20 months old. The ration after that time should be sufficient for her own growth and for the development of the fetus or young calf. The mineral matter of the ration, as found in the legumes and common salt is important for her at this time, especially the lime, phosphorus, magnesium, and iron content. A lack of these substances will result in a weak, small-boned calf being dropped, and the effort of the cow to supply them from her own body will weaken and stop her growth. Unless well fed and cared for she will be unable at the same time to give sufficient milk to nourish it properly without an additional tax upon her own body.

Previous to calving time the ration, especially the bulky part of it, should be reduced and made slightly laxative. Wheat bran, oats, and linseed-oil meal are desirable for this purpose. If the animal is on pasture no special attention to the ration need be given. During the winter legume hays should be provided if possible. Use little corn, cottonseed meal, or similar feeds previous to calving.

If the heifer has been properly fed and cared for up to calving time and has had plenty of exercise she will need no assistance and little if any attention. This is especially true in good weather if

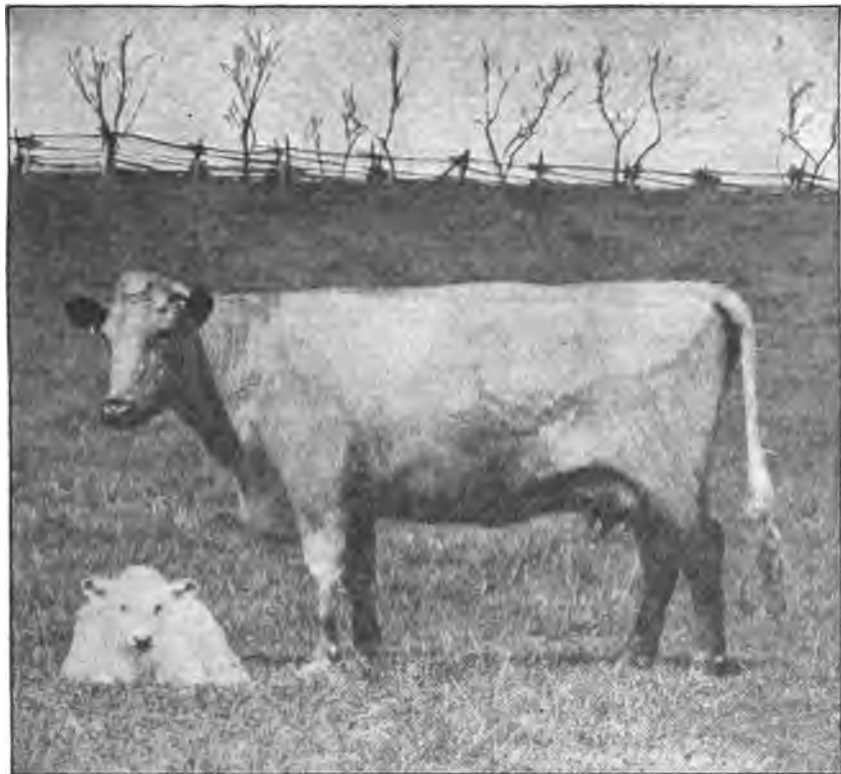


FIG. 23.—Cows that drop their calves in pasture rarely need attention at the time.

the cow is allowed to calve on pasture (fig. 23). It is important that she be not disturbed by other animals. Put her into a grass lot or small pasture, if possible, by herself, away from ponds, streams, or rough, steep hillsides. In winter a well-bedded box stall should be arranged. Do not tie the cow, but give her the freedom of the stall. It is best to keep out of sight as much as possible, only observing her occasionally, to be ready to give any help needed.

After the calf has been dropped allow the cow to care for it alone. Observe them, however, to see that the calf is soon able to stand and suck. It is important that the calf get the cow's first milk.

FEED AND CARE OF THE BULL.

The bull calf retained for breeding purposes, like the heifer, should not be allowed to shift for himself with the rest of the herd. He should be given a separate pasture in summer and a box stall with a lot for exercise in winter. Other bull calves or a bred cow or heifer should be put into the same lot for company. The box stall or shed should be near other cattle for the same reason.

The feeds for the bull should be similar to those for the heifer. They should be fed in sufficient quantities to keep him in a strong, vigorous condition at all times. The bull is considered as being one-half, or more, of the herd. You may, therefore, starve and stunt the principal part of your herd by neglecting the bull and not realize the serious consequences until too late.

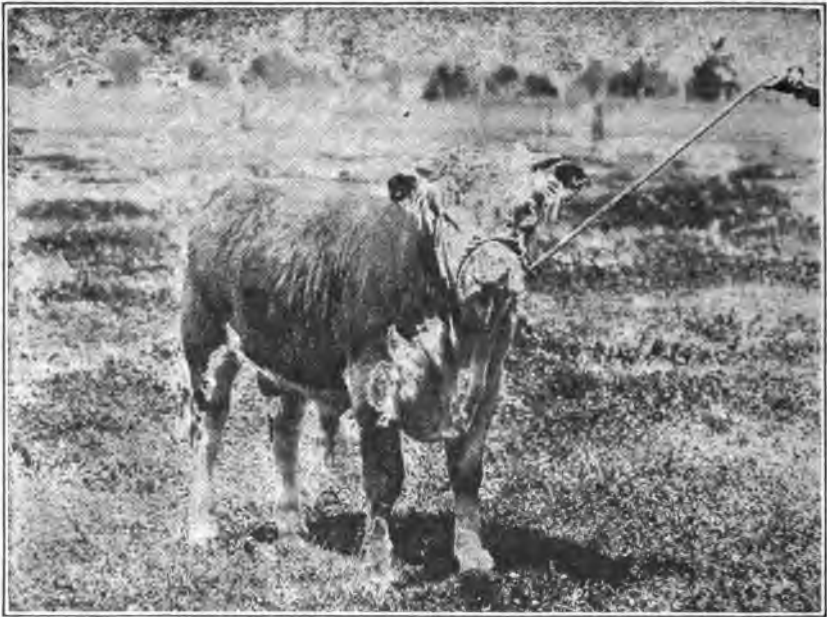


FIG. 24.—The bull calf should be taught to lead and stand correctly.

The bull, if well grown and cared for, may be used in a limited way for breeding purposes when 18 months old. It would be better if he were 2 years old or more before being used heavily.

It is important that the bull calf be taught to lead and to stand tied when about a year old. It will enable you to handle him more easily and with less danger to yourself. It will impress upon him the fact that you are his master, and he will soon learn to mind you as well as depend upon you for just and proper treatment.

FARMERS' BULLETIN 1136
UNITED STATES DEPARTMENT OF AGRICULTURE

BAKING IN THE HOME



MUCH OF THE BAKING in this country is done in the homes, and many housewives are desirous of knowing how to make not only really good yeast bread but also quick breads, pastry, etc. Many persons have learned to enjoy breads and other baked products not made entirely of wheat flour and wish to continue their use. Almost every section of the country produces abundant crops other than wheat, such as corn, rye, barley, buckwheat, rice, potatoes, sorghum grains, and others, which may well be utilized in baking. An increased local consumption of such crops would mean a saving to the community as well as to the country at large, and would lessen unnecessary transportation.

To enable the housewife to make a great variety of breads and other articles of other substances as well as of wheat, the following recipes and directions have been prepared.

Contribution from the States Relations Service

A. C. TRUE, Director

Washington, D. C.

December, 1920

BAKING IN THE HOME.

HANNAH L. WESSLING.

Assistant in Home Demonstration Work, Office of Extension Work South.

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THERE is no other single article of food that is as frequently placed on the table or takes as prominent a place in the average diet as bread. In some form or other it is served at practically every meal, and many times bread is the chief article of the meal. Properly balanced with milk, butter, fruits, vegetables both leafy and fleshy, eggs, cheese, or a little meat, bread may well form a considerable part of our daily food. Bread and other cereal products are also among the least expensive of our foods.

As it occupies so prominent a place in the diet, bread ought certainly to be well made, well baked, and properly cared for. Moreover, any girl or woman who desires to be known as a really good cook, will wish to excel particularly in bread making. An ideal loaf of bread is attractive in appearance; crust smooth, tender, and golden brown in color; the loaf itself light and well-rounded on top; the crumb spongy and tender; and the whole delicious in flavor.

Many housewives who do not care to bake yeast bread frequently prepare "hot" or "quick" breads for the home table. It is well, therefore, to emphasize the desirable characteristics of quick breads also, in order that these, too, may be as well made and well baked as possible. Hot breads, because of their freshness and softness, are often swallowed hurriedly and without thorough mastication,

hence it is especially important that thorough baking, lightness, and porosity should be sought in their preparation, as well as good flavor and attractive appearance.

Although wheat is the leading bread cereal in this country and wheat flour the flour of prime importance, housewives have learned that many desirable products may be made from meals of other substances or from a mixture of these with wheat flour. This country has a considerable number of products which may be thus used, such as corn, rye, oats, buckwheat, barley, rice, feterita, milo maize, potatoes, peanuts, soy-bean meal, and the flour made from peanut and soy-bean press cake. The local use of these products where they occur in quantity will be of great economic value by saving a large amount of unnecessary transportation of food materials.

The following directions and recipes deal not only with articles made from wheat alone but also with those into which other products enter. All measurements are *level*.

YEAST BREADS.

GENERAL CONSIDERATIONS.

Cleanliness.—To assure success in bread making it is important to maintain absolute cleanliness with regard to the materials used, as well as the utensils and the hands. Do not put the fingers unnecessarily into food materials nor handle them when it can be avoided. It is better to place your hand on the outside of the cup or pan in which the liquid is cooling to test its warmth, or to let one or two drops of the same fall onto your hand or wrist than to plunge your finger, nail and all, into the liquid.

Flour.—The flour should be sound and free from foreign taste or odor. Hard-wheat flours, made from spring wheat or hard winter wheat, are often known as *bread flours* and usually produce a somewhat larger and more spongy loaf. Soft-wheat flours are made from soft winter wheats and are known as *pastry* or *biscuit flours*. They are better adapted than are hard-wheat flours to the making of quick breads, and they require a little less shortening. Somewhat more soft-wheat flour is required to combine with a given volume of liquid than hard-wheat flour, because the latter has a greater water-absorbing capacity.



The bread-making quality of flour depends to a large extent upon the amount and character of the gluten it contains. Gluten is the elastic, gum-like substance obtained when flour is moistened and allowed to

stand for a while and which makes the dough pliable and tenacious. There is more gluten in wheat than in any other cereal, and it is of such a character that wheat flour yields a lighter and more springy bread than any other kind of flour. Hard-wheat flours are superior in this respect to soft-wheat flours and are therefore better adapted to the making of yeast breads.

Hard-wheat flour feels slightly gritty when rubbed between the fingers. When pressed tightly in the hand, it does not retain the imprint of the fingers very long and when shaken briskly soon falls to powder. The spring wheats are grown in the Northern Plains section of this country, e. g., Minnesota, the Dakotas, and parts of Montana. The hard winter wheats are produced in the section which includes Kansas, Nebraska, Oklahoma, and northern Texas.

Soft-wheat flour feels very soft and smooth when rubbed between the fingers; it retains the imprint of the fingers and does not fall to powder very readily after compression. The soft wheats are found very generally in the South, in the States east and south of Lake Michigan, and in some of the far Western States, particularly on the Pacific coast.

In some sections of the country, especially in the region including Indiana, Ohio, Kentucky, Pennsylvania, and other States, many millers blend the locally grown soft-wheat flour with a certain proportion of a hard winter or spring wheat flour. This blended flour is often referred to as "an all-around flour," producing better yeast bread than does soft-wheat flour alone, and yielding very good biscuits and other baking-powder products.

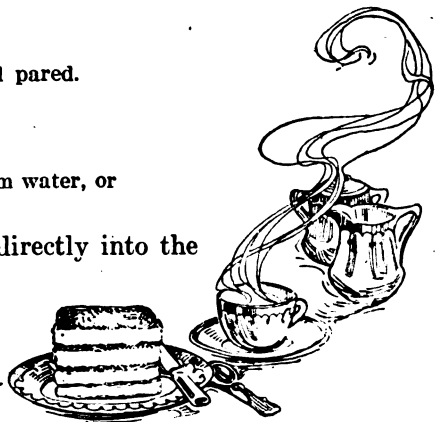
Yeast.—Compressed yeast, if used, should be as fresh as possible and free from any odor other than the well-known yeasty odor. It should be fairly soft, but should break easily. It should never be mixed with any liquid which is more than lukewarm.

Liquid yeast should always be kept covered and in a cool place. It should have a yeasty odor only and should not be kept more than two weeks without freshening.

LIQUID YEAST.¹

- 4 medium-sized potatoes, washed and pared.
- 1 quart hot water.
- $\frac{1}{2}$ cup sugar.
- 1 teaspoon salt.
- 1 cake dry yeast soaked in $\frac{1}{4}$ cup warm water, or
- 1 cake compressed yeast.

Grate or grind the potatoes directly into the water (a food grinder is convenient for the purpose). Boil about 5 minutes, stirring constantly. Add the sugar and



¹ See Farmers' Bul. 807, p. 9.

salt and allow the mixture to cool. When lukewarm, add the yeast. Keep at ordinary room temperature (about 70° F.) for 24 hours, when it will be ready for use. This yeast should be kept in a cool, dark place. An earthen jar or enamel-ware pail is a good container for it and should be scalded before the yeast is put into it.

During the summer season it is difficult to keep liquid yeast and in many places compressed yeast can not be obtained. One cake of dry yeast will serve the same purpose as one of compressed yeast if the sponge process be used. Dry yeast should be soaked in water for 20 minutes to 1 hour before using, to bring the yeast cells back to an active state. The use of dry yeast calls for the long-fermentation method, to give time for sufficient growth of yeast cells to make the dough light.

Liquid.—The liquid used in bread making may be whole milk, skim milk, water, whey, the water in which pared potatoes have been cooked, or combinations of these liquids.

If milk (whole or skimmed) be used in bread making, it should be scalded and cooled until lukewarm; that is, its temperature should be between 80° and 90° F. before adding it to the dough. The use of milk increases the food value somewhat and gives to the loaf a desirable tenderness and richness, besides keeping it moist longer than does water alone.

A small amount of potato water or of mashed potato added to the sponge or dough in bread making will hasten the fermentation appreciably, and the resulting bread will remain moist longer than ordinarily.

Temperature.—If a sponge is set at night it should be kept at ordinary room temperature or less (60° to 75° F.), depending upon how long it is to stand. If the "straight-dough method" is used, or whenever a *dough* (as distinguished from a sponge) has been prepared, the temperature should be fairly warm (between 80° and 88° F.), except when it is to stand a long time, as overnight. The time for rising required in the following recipes depends upon such temperature being maintained.

Crust on dough.—The dough should always be kept covered with a lid or plate, in order to prevent surface evaporation resulting in the formation of a crust on the dough. When thus covered it is unnecessary to grease the surface of the dough.

Indicator.—When molding the loaves a bit of dough should be pinched off, shaped into a ball, and placed in a small jelly glass. Its volume when placed in the glass should be noted and the glass marked at twice and three times this volume. This "indicator" should stand alongside the pans while the loaves are rising. If spring or hard winter wheat flours alone are used in bread making, the loaves should be placed in the oven when the dough in the indicator rises to three times the original volume. If soft winter wheat

flour is used, the loaves are ready for baking when the indicator shows about $2\frac{1}{2}$ times the original volume.

When the loaves are ready for the oven place the ball of dough in a small greased tin, let stand about 15 minutes, then bake it while the loaves are still in the oven.

Pan.—For a so-called “standard” homemade loaf, one cup liquid and usually from three to four cups wheat flour are required. The exact amount of flour for a given amount of liquid (or vice versa) can not be given in these recipes, because there is so much variation in this respect among different flours, and even in the same flour at different times. The most satisfactory pan for this amount of dough should hold 3 pints, and would be approximately $7\frac{1}{2}$ inches long, $3\frac{1}{2}$ inches wide, and 3 inches deep. Bake loaves of this size about 50 minutes.

Temperature of the oven.—When the dough is fully risen for baking, i. e., has increased to two and one-half or three times its bulk, depending upon the kind of flour, it should be put into a fairly hot oven at first (400° to 425° F.), in order that the crust may begin to form before it becomes overrisen at the top.

If for any reason a dough must be baked before it is fully risen, it should be put into a cooler oven (325° to 375° F.), in order to give it a chance to rise fully before the crust forms and thus prevent an unsightly crack across the top or at the side of the loaf. After this rising in the oven has taken place the heat should be increased to 400° or 425° F., and later lowered again if necessary.

Testing heat of the oven.—The best method of testing the heat of the oven is by means of an oven thermometer.² When no thermometer is at hand the following test may be used: Place $\frac{1}{2}$ teaspoon of flour in a small tin like the lid of a jelly glass, spreading it in a layer about $\frac{1}{4}$ inch thick. Place this in the oven, and if the heat is right for bread baking the flour will become light golden brown throughout within five minutes. This browned flour should be saved and used for thickening gravies or sauces.

METHODS FOR MAKING BREAD.

There are two general methods for making bread, one known as the “straight-dough” process and the other as the “sponge” process.

Straight-dough process.—In the “straight-dough” process all the ingredients are mixed at one time and the dough is made of the proper consistency before rising. Either compressed or liquid yeast may be used for this, but not dry yeast.

Sponge process.—In the “sponge” process only half the total amount of flour is used at first, with all or nearly all of the liquid,

² Oven thermometers may be obtained from manufacturers or dealers in scientific instruments. The thermometer which accompanies most commercial fireless cookers will serve very well.

the yeast, and frequently the salt and the sugar. Compressed, dry, or liquid yeast may be used for this. This mixture is similar to a soft batter, and after the first rising the remainder of the flour, the shortening, and any other desired ingredients are added. It is then kneaded until of the proper consistency and smoothness.

The sponge process usually requires less yeast than the straight-dough method, because of the softer consistency of the mixture which facilitates the growth of the yeast. However, by using larger or smaller amounts of yeast one may shorten or lengthen the time required for rising. In a similar way the straight-dough process may be shortened or lengthened by increasing or decreasing the amount of yeast used. Hence, recipes for the different variations of time are given and the housewife may select that which suits her convenience as to time and the kind of yeast she has on hand, or which seems to her most economical. Great care should be taken when using a sponge or dough which stands a long time—as, for example, the “overnight straight dough” or the “overnight sponge”—to keep it much cooler than when the quicker methods are used, since the former have a greater chance of becoming sour.

For the convenience of extension workers or others who need to make a small quantity of bread at a time for demonstration purposes, a recipe of one loaf is included as well as that for four loaves, which may be regarded as an average baking for a family.

SHORT PROCESS OR STRAIGHT DOUGH.

(One loaf.)

1 cup lukewarm liquid.	$\frac{1}{4}$ to $\frac{1}{2}$ cake compressed yeast, or
1 teaspoon salt.	2 to 4 tablespoons liquid yeast.
$\frac{1}{2}$ tablespoon sugar.	3 to 4 cups sifted flour.
$\frac{1}{2}$ tablespoon shortening, if desired.	

(Four loaves.)

4 cups (1 quart) lukewarm liquid.	1 or 2 cakes compressed yeast, or
4 teaspoons salt.	$\frac{1}{2}$ to 1 cup liquid yeast.
2 tablespoons sugar.	3 to 4 quarts sifted flour.
2 tablespoons shortening, if desired.	

If milk is used it should be scalded and cooled until lukewarm before using. When liquid yeast is used its volume must be deducted from the other liquid called for.

Mixing.—Soften the yeast with a small amount of the lukewarm liquid. To the rest of the liquid add the salt, sugar, and shortening. Add the yeast and mix all together. Measure the sifted flour into a bowl and blend with the liquid. If too soft to knead, add more flour until of the proper consistency. Knead 5 to 10 minutes or until smooth, elastic, and no longer sticky. Cover with a lid or plate and place where it will be away from drafts and at a uniform tem-

perature of 80° to 88° F. Let rise until about double its original bulk or until a slight touch of the finger leaves an impression. This should happen within 1 to 2 hours if the yeast is in good condition and the temperature right.

Kneading.—Cut down the dough from the sides of the bowl and knead. Should the dough be too soft, add flour, a little at a time, kneading until it is smooth, elastic, and free from large gas bubbles. If the dough be too stiff, add a little water, working it in well, and knead until the dough no longer sticks to the fingers or bowl. Cover and set aside in the same warm place for an hour or an hour and a half, or until very light and at least double in bulk.

Molding.—Cut down the dough from the sides of the bowl and knead again to expel the large bubbles of gas. Divide into approxi-

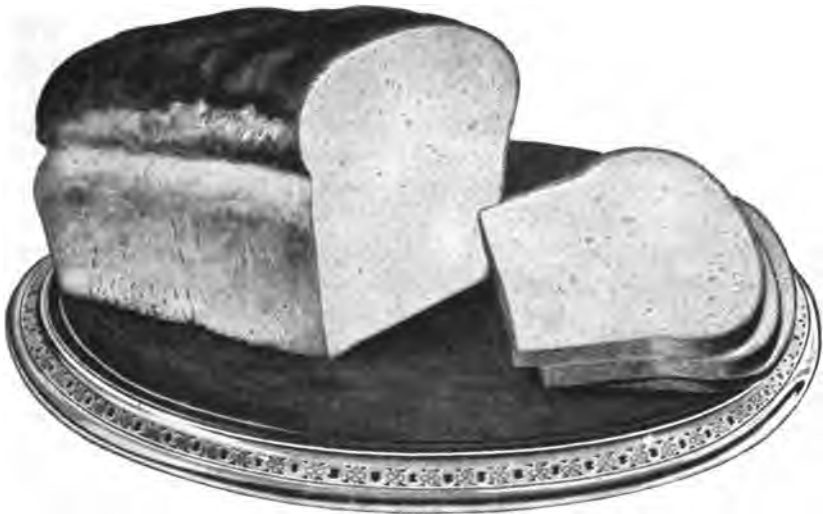


FIG. 1.—Bread made by the short process or straight-dough method.

mately equal proportions; mold quickly, stretching the outside of the loaf and pinching together underneath; place, crease side down, in a lightly greased pan which has been warmed but is not hot. Cover and set the loaf in the same warm place and allow to rise 50 minutes to 1 hour, or until the indicator shows from $2\frac{1}{2}$ to 3 times the original volume, depending upon the kind of flour used. (See p. 6.)

Baking.—Loaves made with 1 cupful of liquid each should be baked 50 minutes if in separate pans, in an oven heat regulated as described. They should begin to brown in about 15 minutes. After that time, the temperature of the oven should be lowered gradually to 375° F., so that the crust will not become too hard.

It is better to place the pans in the oven not touching each other, so that the air will circulate around them. Unless the oven bakes very evenly, it will be necessary to turn the pans around occasionally, or to change their position, in order to have loaves of good shape.

Bread is done when it shrinks from the pan; when the under crust and the edges of the upper crust rebound if pressed back by the finger instead of becoming permanently dented; when it makes a singing sound perceptible if the ear is placed very close to the loaf. Surest of all is an old test, the use of a probe which is run into the center of the loaf and which should come out clean. This test is not really necessary, however, and the probe used must be perfectly clean, and never should be a dirty broom straw. Clean straws from a new broom may be used or any others that are perfectly clean.

Cooling bread.—After baking, place the loaves on a cooling rack or else across the edges of the pans and allow to cool thoroughly. Do not cover while cooling unless it is necessary to prevent contamination by dust or flies. When thoroughly cool, place the loaves in a perfectly clean, well-aired, and covered box of tin or aluminum, or in a stone crock.

SHORT SPONGE METHOD.

(One loaf.)

1 cup lukewarm liquid (or 2 table- spoons less if potato is used).	$\frac{1}{2}$ to $\frac{1}{2}$ cake compressed yeast, or 2 to 4 tablespoons liquid yeast.
1 teaspoon salt.	$\frac{1}{2}$ cup mashed potato (if desired).
$\frac{1}{2}$ tablespoon sugar.	3 to 4 cups sifted flour.
$\frac{1}{2}$ tablespoon shortening (if desired).	

(Four loaves.)

4 cups (1 quart) lukewarm liquid (or $\frac{1}{2}$ cup less if potato is used).	1 or 2 cakes compressed yeast, or $\frac{1}{2}$ to 1 cup liquid yeast.
4 teaspoons salt.	1 cup mashed potato (if desired).
2 tablespoons sugar.	3 to 4 quarts sifted flour.
2 tablespoons shortening (if desired).	

Mixing.—Soften the yeast with a small amount of the lukewarm liquid; to the rest of the liquid add the salt and sugar, mix this with the cool potato and add the softened yeast. Measure half the required amount of flour into a bowl and blend with this the yeast mixture. Beat thoroughly until smooth. Cover and set to rise in a moderately warm place (80° to 88° F.) When liquid yeast is used its volume must be deducted from the other liquid called for.

Kneading.—When quite light and full of bubbles, or after 1 to 1½ hours if the yeast is good, break up this sponge, add the melted shortening (if used) and the rest of the flour or enough to make a dough that can be kneaded. Knead until the dough is smooth and elastic and no longer sticks to the bowl or fingers. Cover and set aside again to rise.

Molding and baking.—When the dough has become very light and at least double in bulk, follow directions for molding and baking given under “short process,” page 9.

OVERNIGHT SPONGE METHOD.

(One loaf.)

1 cup lukewarm liquid (or 2 table- spoons less if potato is used).	½ cake yeast (dry or compressed) or 2 tablespoons liquid yeast.
1 teaspoon salt.	½ cup mashed potato (if desired).
½ tablespoon sugar.	3 to 4 cups sifted flour.
½ tablespoon shortening (if desired).	

(Four loaves.)

4 cups (1 quart) lukewarm liquid (½ cup less if potato is used).	1 cake yeast (dry or compressed), or ½ cup liquid yeast.
4 teaspoons salt.	1 cup mashed potato (if desired).
2 tablespoons sugar.	3 to 4 quarts sifted flour.
2 tablespoons shortening (if desired).	

If *dry* yeast is used, soak it 20 minutes to 1 hour before mixing the sponge and mix the sponge earlier than if compressed or liquid yeast is used. When liquid yeast is used its volume must be deducted from the other liquid called for.

Mixing.—Blend the yeast with a little of the lukewarm liquid. If potato is used add to it the salt, then the yeast mixture, the remainder of the liquid, and finally one-half of the flour. Beat until smooth, cover, and set to rise where it will be at 60° to 70° F.

Kneading.—In the morning break up the sponge, add sugar, the melted shortening (if used), and enough flour to make a dough of the proper consistency. Knead until the dough is smooth, elastic, and no longer sticks to the bowl or fingers. Cover and set to rise until at least double in bulk.

Molding and baking.—See directions for molding and baking under “short process,” page 9.

OVERNIGHT STRAIGHT-DOUGH METHOD.

(One loaf.)

1 cup lukewarm liquid (or 2 table- spoons less if potato is used).	½ cake yeast (dry or compressed), or 2 tablespoons liquid yeast.
1 teaspoon salt.	½ cup mashed potato (if desired).
½ tablespoon sugar.	3 to 4 cups sifted flour.
½ tablespoon shortening if desired.	

(Four loaves.)

4 cups lukewarm liquid (1 quart) (½ cup less if potato is used).	1 cake yeast (dry or compressed), or ½ cup liquid yeast.
4 teaspoons salt.	1 cup mashed potato (if desired).
2 tablespoons sugar.	3 to 4 quarts sifted flour.
2 tablespoons shortening (if desired).	

Mixing and kneading.—When liquid yeast is used its volume must be deducted from the other liquid called for. If *dry* yeast is used, soak it 20 minutes or more. Make up a sponge as directed under “overnight sponge method,” page 11, early in the afternoon, keeping it between 80° and 88° F. At night knead it stiff according to same directions.

If *compressed* or *liquid* yeast is used, follow directions for mixing under “short process,” page 8, using the mashed potato, if desired, and the amount of yeast suggested above. Mix and knead at night, cover and keep between 60° and 75° F. overnight.

Molding and baking.—When the dough has become very light and at least double in bulk, follow directions for molding and baking given under “short process,” page 9.

GRAHAM OR WHOLE-WHEAT BREAD.

(One loaf.)

3 cups or more graham flour or wheat meal.	1 or 2 tablespoons sweetening.
1½ cups lukewarm liquid.	½ to ¾ cake yeast (dry or compressed),
1 teaspoon salt.	or 2 to 4 tablespoons liquid yeast
	(deduct from other liquid).

Short process.—Dissolve the salt and sweetening in 1 cup lukewarm liquid, and to this add ½ cake compressed yeast blended with ¼ cup lukewarm water (or 4 tablespoons liquid yeast). Mix with this sufficient graham flour to form a dough not too stiff. Knead until smooth and elastic. Cover and allow to rise until quite light (at least double in bulk). Knead down, mold, place in greased pan, and allow to rise until just double in volume. Bake at least one hour in a moderately hot oven. If desired, the dough may be allowed to rise twice before being molded for the pan. Whole-wheat dough must have less rising than that made with ordinary flour.

Long process.—Make a sponge of ¾ cup lukewarm liquid, 1 teaspoon salt, ½ cake yeast (dry or compressed) blended with ¼ cup lukewarm water, or 2 tablespoons liquid yeast, and 1½ cups graham flour. When dry yeast is used, it must be soaked in a portion of the liquid for 20 minutes to 1 hour before adding to the sponge. Cover and let rise overnight or until very light. In the morning break up this sponge, add ¼ cup liquid at about 90° F., the sweetening, and enough more graham flour to make a dough not too stiff. Knead until smooth and elastic. Mold and finish as directed above, or allow to rise a second time before molding. A satisfactory loaf of part graham may be made by using ½ or ¾ white flour with the remainder graham. If the sponge process be used, make the sponge with the white flour and when kneading it stiff use the graham. This loaf will have more bulk than that made of graham flour alone and will be relatively lighter.

RAISIN BREAD.

(One loaf.)

1 cup lukewarm liquid (preferably milk).	2 to 4 tablespoons liquid yeast.
1 teaspoon salt.	3 to 4 cups sifted flour.
2 tablespoons sugar.	$\frac{1}{2}$ cup seeded raisins.
2 tablespoons shortening.	When liquid yeast is used, deduct amount of it from the rest of the liquid.
$\frac{1}{2}$ to $\frac{1}{4}$ cake yeast, or	

Straight-dough method.—Mix the dough at night if the smaller amount of yeast is used, or in the morning if the larger amount is to be used, following directions given under “overnight straight dough,” page 11, or the “short process,” page 8. When the dough is ready for molding cut it down, add the raisins previously dredged with flour, knead them in well, form into loaf shape, and place in greased tin. When quite light according to the indicator, bake in moderate oven about 50 minutes.

Sponge method.—Make a sponge with 1 cup of liquid as described under “overnight sponge,” page 11, if the smaller amount of yeast is used, or under “short sponge method,” page 10, if the larger amount is to be used. When the dough has been kneaded stiff and has risen again add the raisins previously dredged with flour, kneading them in thoroughly. Shape into a loaf, place in greased tin, let rise until quite light according to the indicator; and bake in a moderate oven about 50 minutes.

If desired, the top of the loaf may be brushed with a solution of 1 teaspoon of sugar in $\frac{1}{2}$ cup of milk or hot water, immediately upon removal from the oven

A delicious raisin loaf is made by using one-half graham and one-half white flour in any of the above recipes.

PEANUT BREAD.

(One loaf.)

1 cup lukewarm liquid.	$\frac{1}{2}$ to $\frac{1}{4}$ cake yeast (dry or compressed),
1 teaspoon salt.	or
3 cups flour (more if necessary).	2 to 4 tablespoons liquid yeast (deduct from other liquid).
1 or 2 tablespoons sweetening.	
1 cup peanut meal or peanut flour.	

The peanut meal used in this bread may be prepared by shelling roasted peanuts, removing red skin, and crushing the nuts with a rolling pin or putting them through a food chopper. Peanut flour (such as may be purchased in some localities) is much improved in flavor if slightly parched before using. Place a portion of it in a shallow pan and heat carefully in the oven until light brown in color, stirring frequently to prevent scorching.

Short process.—Dissolve the salt and sweetening in the cup of lukewarm liquid. Mix with it the compressed yeast ($\frac{1}{2}$ cake) blended with a small portion of the liquid (or 4 tablespoons liquid yeast),

and add all to the mixture of flour and peanut meal. Knead until smooth and elastic, adding more flour or liquid, if necessary, to secure proper consistency. Cover and let rise until quite light. If desired, knead down and let rise a second time until very light. Then knead lightly, pinch off a bit for the indicator, mold the rest, place in greased pan, cover, and let rise until at least $2\frac{1}{2}$ times the original bulk. Bake 50 to 60 minutes in a moderately hot oven (400° F.).

Long process.—Make a sponge of $\frac{1}{2}$ cup lukewarm liquid, 1 teaspoon salt, $\frac{1}{4}$ cake yeast, dry or compressed, blended with $\frac{1}{4}$ cup lukewarm water (or 2 tablespoons liquid yeast), and $1\frac{1}{2}$ cups flour. Beat well, cover, and set aside where it will be between 60° and 70° F. if possible. When thoroughly light, add to this sponge $\frac{1}{4}$ cup water at about 90° F., to which has been added the sweetening and the mixture of peanut meal and $1\frac{1}{2}$ cups flour. Knead until smooth and elastic, adding more flour or liquid if necessary. Cover and set aside until light. Then knead down mold, and finish as directed under "short process" above.

Any other dry meal, or flour, obtained from corn, rice, kafir, milo, feterita, buckwheat, barley, finely ground rolled oats, millet, chick pea, navy beans, peas, chestnuts, bananas, dasheen, or cassava may be used in place of the peanut meal in the above recipe. Somewhat more liquid will probably be required with some of these meals than when peanut is used.

POTATO BREAD.

(One loaf.)

1 cup mashed sweet or Irish potatoes.	4 tablespoons lukewarm water (more if necessary).
1 teaspoon salt.	$2\frac{1}{2}$ cups or more sifted flour.
$\frac{1}{2}$ tablespoon sugar.	$\frac{1}{4}$ to $\frac{1}{2}$ cake yeast (dry or compressed),
$\frac{1}{2}$ tablespoon shortening, if desired.	or 2 to 4 tablespoons liquid yeast.

Use left-over boiled or baked potatoes, or boil potatoes in their skins until tender. Peel and mash the potatoes or put them through a colander or ricer to free them from lumps. If cold left-over potatoes are used, put them into boiling water for a few minutes, in order to facilitate the mashing or ricing process. When liquid yeast is used it must be included in the total liquid.

Short process.—To 1 cup of the cool mashed potato add 1 teaspoon salt, $\frac{1}{2}$ tablespoon sugar, the shortening (if used), and $\frac{1}{2}$ cake compressed yeast mixed with 4 tablespoons lukewarm water, or 4 tablespoons liquid yeast. Mix with this $\frac{1}{2}$ to 1 cup sifted flour, stirring until thoroughly blended. Cover and allow to rise until soft and light (about 2 hours). Knead in enough more flour to make a dough somewhat stiffer than for white bread. If the potatoes are rather dry or mealy, a little additional water may be required. Knead until smooth and elastic. Cover and let rise again until very light (about

1 hour). Then knead down, mold, and finish as usual. Allow to rise in the pan until $2\frac{1}{2}$ to 3 times the original bulk. Bake slowly in a moderate oven about 1 hour.

Long process.—To 1 cup of the cool mashed potatoes add 1 teaspoon salt and $\frac{1}{4}$ cake yeast, dry or compressed, mixed with 4 tablespoons lukewarm water, or 2 tablespoons liquid yeast and 2 of water. Add to this $\frac{1}{2}$ to 1 cup sifted flour, cover and set to rise where it will be between 60° and 70° F. When thoroughly light and soft add to it the sugar and shortening, and knead in enough more flour to form a smooth, elastic, and rather stiff dough. Cover and allow to rise again until very light. Then knead down, mold, and finish as directed under "short process" above.

Cooked or baked squash, pumpkin, peas, beans, or dasheen may be used in place of the potato.

RICE BREAD.

(One loaf.)

1 cup boiled rice.	4 tablespoons lukewarm water (more if necessary).
1 teaspoon salt.	$2\frac{1}{2}$ cups or more sifted flour.
$\frac{1}{2}$ tablespoon sugar.	$\frac{1}{2}$ to $\frac{1}{4}$ cake yeast (dry or compressed),
$\frac{1}{2}$ tablespoon shortening, if desired.	or 2 to 4 tablespoons liquid yeast.

Left-over rice may be used, or broken rice may be especially cooked for this purpose, using $\frac{1}{2}$ cup uncooked rice with 1 cup water for each loaf to be made. Cook rice until very tender, and, if desired, put it through a ricer or colander.

Follow directions given for potato bread, page 14, using cooked rice instead of the potato.

CORN-MEAL LIGHT BREAD.

(One loaf.)

1 cup corn-meal mush, cooked grits or fine hominy.	4 tablespoons lukewarm water (more if necessary).
1 teaspoon salt.	$2\frac{1}{2}$ cups or more sifted flour.
$\frac{1}{2}$ tablespoon sugar.	$\frac{1}{2}$ to $\frac{1}{4}$ cake yeast (dry or compressed),
$\frac{1}{2}$ tablespoon shortening, if desired.	or 2 to 4 tablespoons liquid yeast.

Use left-over mush, grits, or fine hominy, or prepare a mush of $\frac{3}{4}$ cup dry corn meal and $1\frac{1}{2}$ cups water. Cook 10 minutes to 1 hour in a double boiler, or in a vessel placed in another containing boiling water. Cool the mush until lukewarm, then follow directions given on page 14 for making potato bread, substituting corn-meal mush for the potato.

Any other cooked cereal, either prepared for this purpose or left-over portions, may be used in place of the corn-meal mush. If the cereal has been previously salted, use only $\frac{1}{2}$ teaspoon salt per loaf.

LIGHT ROLLS.

Sponge method.—To the sponge made with 1 cup of liquid (see directions for “short” or “overnight” sponge, pp. 10, 11), when thoroughly light, add 2 tablespoons of melted shortening, 1 or 2 tablespoons of sweetening, and one well-beaten egg, if desired. Knead in enough flour to make a dough not too stiff. Knead until smooth and elastic. Let rise again before molding, or shape at once into balls by rolling a bit of dough the size of an egg between the palms of the hands. Place close together or somewhat apart, depending on whether a soft or a crusty roll is desired. Let rise in the pan until trebled in bulk and bake about 25 to 35 minutes in a fairly hot oven. When placed close together these rolls should bake the longer period of time.



FIG. 2.—Plain light rolls.

Straight dough.—To a portion of dough equivalent to 1 loaf (or made with 1 cup liquid according to directions for “straight dough,” pp. 8, 11) add 2 tablespoons melted shortening and 1 or 2 tablespoons sugar. Knead until smooth and elastic, adding a little flour if necessary. Pinch off small portions of dough, shape into balls as described above, and place in pan with smooth side uppermost.

CLOVER-LEAF ROLLS.

When shaping the rolls pinch off quite small portions of dough about the size of a marble, roll between the palms of the hands, and place three together in each compartment or cup of ordinary gem pans, previously greased. The cups should be only half full. Let rise until treble in bulk and bake about 25 minutes in a fairly hot oven.

"4-H CLUB" ROLLS.

It has been suggested that in the preceding directions four tiny balls of dough be placed into each cup of the gem pans, forming a four-leaf clover roll, symbolic of the 4-H clubs.

GRAHAM-RYE ROLLS OR LOAF BREAD.

(Twelve rolls.)

- | | |
|--------------------------------|---|
| 1½ cups rye flour. | ½ to ¾ cake yeast (dry or compressed), or 2 to 4 tablespoons liquid yeast.
1 cup (or more) lukewarm water. |
| 1½ cups graham flour. | |
| 1 teaspoon salt. | |
| 1 or 2 tablespoons sweetening. | |
| 1 tablespoon shortening. | |

When liquid yeast is used its volume must be deducted from the other liquid called for.

Make a sponge with the rye flour, the salt, yeast, and water. Let



Fig. 3.—Parker House rolls.

rise until very light. Break up the sponge, add the sweetening, the softened shortening, the graham flour and, if necessary, enough more liquid to make a spoon dough so stiff that it will barely drop from the spoon. Place the dough in greased gem pans, filling them half full, let rise until double in bulk, and bake 25 to 30 minutes in a medium hot oven.

By adding a little more rye or graham flour the dough may be made stiff enough to knead. Then let rise again, mold as loaf, let rise in pan until double in bulk, and bake at least one hour in a moderate oven.

GRAHAM-KAFIR ROLLS.

(Twelve rolls.)

- | | |
|----------------------------------|--|
| 2 cups graham flour. | 1 teaspoon salt.
1 or 2 tablespoons sweetening.
1 tablespoon shortening (melted).
½ to ¾ cake yeast (dry or compressed),
or 2 to 4 tablespoons liquid yeast. |
| ½ cup kafir flour. | |
| ½ cup white flour. | |
| 1 cup (or more) lukewarm liquid. | |

When liquid yeast is used its volume must be deducted from the other liquid called for.

Make a sponge with 1 cup graham flour, $\frac{1}{2}$ cup white flour, 1 cup lukewarm liquid, the salt, and yeast. Cover and allow to rise until quite light. Break up this sponge, add to it the sweetening, the shortening, $\frac{1}{2}$ cup kafir flour, and the remaining cup graham flour. If necessary, add enough more liquid to form a soft dough (as for drop biscuits). Beat until smooth and drop at once into greased muffin pans (half full). Let rise until just double in bulk, then bake about 25 to 30 minutes in a moderate oven.

Other materials, such as corn flour, finely ground rolled oats, buckwheat, barley, feterita, or rice flour, may be used in place of the kafir.

RAISED MUFFINS

(About 18 muffins.)

1 cup milk.	1 egg.
2 tablespoons lukewarm water.	$\frac{1}{2}$ cake yeast or 4 tablespoons liquid yeast.
1 teaspoon salt.	About 3 cups sifted flour.
2 tablespoons sugar.	
2 tablespoons shortening (melted).	

The yeast cake must be softened in lukewarm water, or when liquid yeast is used its volume must be deducted from the other liquid called for.

Make a sponge as usual with the yeast, the milk scalded and cooled until lukewarm, the salt, sugar, and enough flour to make a soft batter. Beat thoroughly until smooth, cover, and let rise. When very light, or after about $1\frac{1}{2}$ to 2 hours, break up the sponge, add the melted shortening and the well-beaten egg, and enough more flour to make a "spoon dough." Beat well and drop into greased muffin pans; let rise until at least double in bulk. then bake about 25 minutes in a fairly hot oven.

RAISED COFFEE CAKE.

A portion of the dough prepared according to the preceding recipe may be spread in a greased shallow tin. Sprinkle with sugar and cinnamon, dot with bits of butter; allow to rise until quite light, and bake 15 to 20 minutes in a medium hot oven.

SWEET OR FANCY ROLLS.

Many variations in rolls may be had by shaping the dough into different forms—crescents, finger rolls, or twists, or by adding currants, raisins, chopped nuts, or sugar and cinnamon. The rolls may also be glazed with sugar dissolved in milk or with a thin icing of white of egg and sugar.

FINGER OR DINNER ROLLS.

Dainty dinner rolls are made from the dough for light rolls, when it is ready for molding, by pinching off pieces about the size of a small egg. Roll each piece between the palms of the hands until round, then roll with the hand on a board until 6 inches long and slightly tapering toward the ends. Place about 1 inch apart on a greased baking sheet. Let rise until trebled in bulk, brush with milk, and bake about 20 minutes in a fairly hot oven.

CRESCENTS.

Roll the balls of dough as described for finger rolls and when placing them on the baking sheet form them into crescents, pinching down the ends slightly to hold the shape. Let rise, brush with milk, and bake as described under finger rolls.



FIG. 4.—Fancy sweet rolls.

CURRANT OR CINNAMON BUNS.

Take a portion of dough for light rolls, when it is ready for molding, place on a floured bread board, and roll into a rectangular sheet one-half inch in thickness. Pin down the corners to keep in shape. Spread lightly with softened butter, sprinkle with powdered (or soft) sugar, and strew with currants or cinnamon. Roll up the sheet as for a jelly roll, cut into inch slices, and place on a greased sheet about 1 inch apart. Let rise until about trebled in bulk, sprinkle the top with chopped nuts, or brush with a mixture of sugar and milk, and bake about 25 minutes in a fairly hot oven. If desired, they may be baked without any top coating and iced just a few minutes before taking from the oven.

SCORING BREAD.

It is very helpful, especially for a beginner in the art of bread making, to know what the characteristics of a good loaf of bread are.

Appearance.—First of all, bread should be attractive in appearance. This requires that it should be of good shape, evenly rounded on top, with a smooth unbroken crust, having neither breaks nor bulges. It should be of a uniform golden brown color over the entire loaf.

Lightness.—It should be light, i. e., be relatively large for its weight. A loaf made with 1 cup of liquid will weigh about 18 to 20 ounces and should rise well above the top of a pan holding 3 pints.

Crust.—When the loaf is cut the crust should be found of even thickness over the entire loaf, not more than $\frac{1}{2}$ inch deep, and should be crisp and tender rather than hard and tough.

Color of crumb.—The crumb should be of a pale creamy tint with a satiny luster or sheen as one looks across the loaf, with no dark streaks or patches.

Texture.—The grain of the loaf should be fine and even, having many small cells, more or less uniform in size, rather than fewer cells of larger size. A good bread flour, properly handled during the process of bread making, will usually yield cells oblong in shape rather than round, while the feel of it will be soft and almost velvety.

Elasticity.—The loaf should be elastic so that if pressed rather firmly between the hands it will spring back to its original shape when the pressure is removed. This elasticity is also evident if the cut portion of a loaf is pressed with the fingers and shows no impression after the pressure is removed.

Flavor.—Above everything, however, ranks flavor, for bread is made to be eaten, and no matter how attractive in appearance within or without, the loaf which does not taste and smell good is not a desirable one. It should have the natural sweet, nutty flavor of the baked wheat grain, and there should be no suggestion of sourness or of rancid fat or anything else foreign to a good bread flavor.

Keeping qualities.—In most homes sufficient yeast bread is baked at one time to last for several days. It is very important, therefore, that this bread should keep well until all has been used. It should not mold when kept in a tightly closed bread box for three days, even at a temperature of 90° to 100° F. Nor should the interior of the loaf discolor, become soft or stringy, or develop an unpleasant taste or odor after a few days. Although bread naturally grows somewhat dry and stale when kept thus for several days, unusual dryness may be caused by having the dough too stiff when molded.

Score card for use at home.

	Points.
General appearance-----	10
Shape—roundness of "dome." ²	
Smoothness—no cracks, bulges, lumps, etc.	
Color of crust.	
Lightness-----	10
Crust-----	10
Thickness.	
Quality (crispness and elasticity).	

² When several loaves are baked close together, either in separate pans placed near each other in the oven, or several loaves in the same pan, the symmetrical shape of the individual loaves is marred and allowance for same should be made.

Crumb:	Points.
Color	5
Texture—size and uniformity of cells, thinness of cell walls. No streaks or closeness next to crust.....	15
Elasticity—softness and springiness.....	10
Flavor—Taste and odor.....	30
Sweet, nutty flavor with no off-taste.	
Keeping qualities.....	10
See description above.	
Total.....	100

General score card for white bread.

1. General appearance:	
Shape	5
Smoothness of crust.....	5
Depth and evenness of color.....	5
2. Lightness.....	10
3. Crust:	
Thickness	5
Quality—crispness and elasticity.....	5
4. Crumb:	
Color.....	10
Texture—size and uniformity of cells, thinness of cell walls.....	15
Elasticity—softness and springiness.....	10
5. Flavor—Taste and odor.....	30
Total.....	100

Score card for mixed breads.

1. General appearance (form, smoothness of crust, uniformity and depth of color.....)	15
2. Size and lightness of loaf.....	10
3. Crust (crispness, tenderness).....	10
4. Crumb—color.....	5
5. Crumb—texture (fineness and uniformity of grain).....	10
6. Crumb—elasticity (softness, pliability, springiness).....	10
7. Flavor and odor.....	40
Total	100

QUICK OR HOT BREADS.

In any of the following recipes sour milk or buttermilk and baking soda may be substituted for sweet milk (or water) and baking powder. To guard against an excess of soda, which causes a yellow color in the bread and a less agreeable flavor, use one-half *level* teaspoonful of soda to every *cupful* of sour milk. The soda may be sifted with the other dry ingredients, as is recommended when using baking powder, insuring thorough mixing.

In using either baking powder or sour milk and soda, all materials should be as cold as possible, especially the liquid, and in case of pastry and biscuits it is well also to keep the shortening cold, although it is not always necessary.

The mixing should be done as quickly as possible, especially after the baking powder is moistened, to minimize the loss of leavening gas. Biscuits should be rolled, cut, and placed in the pans as soon as possible after mixing. If necessary, they may stand in the pans before baking with comparative safety if kept cold.

Other sweetening agents may be used in place of sugar; for example, honey, maple, cane or sorghum sirup, molasses, or corn sirup. Honey will replace sugar, measure for measure; that is, one tablespoon or one cupful of honey may take the place of one tablespoon or one cupful of sugar. The other substances decrease in sweetening power in the order named. A slightly larger amount of these would therefore be required in lieu of a given measure of sugar. It must also be remembered that in the following recipes a reduction of $\frac{1}{4}$ cup of other liquid for every cup of sirup used must be made when liquid sweetening agents are used in place of sugar.

BISCUITS.

PLAIN BAKING-POWDER BISCUIT.

(10 small biscuits.)

2 cups sifted flour.
 $\frac{1}{4}$ teaspoon salt.
 2 teaspoons baking powder.

2 tablespoons shortening.
 $\frac{1}{4}$ to $\frac{3}{4}$ cup liquid (milk, water, or equal parts of each.

Sift together the flour, salt, and baking powder. Cut or chop the shortening into the flour with one knife or two, until well distributed. Finally, if necessary, rub the mixture between the tips of the fingers until it is like a meal. Add just enough cold liquid to make a soft dough that can be handled on the board, mixing with a knife if possible. Mix quickly and handle the dough very lightly. Place it on a floured board, roll to the thickness of $\frac{1}{2}$ inch, and cut into desired shape. Place the biscuits on a baking sheet or in shallow tins dusted lightly with flour, and bake in a rather hot oven 10 to 15 minutes or until thoroughly baked.

DROP BISCUITS.

To save time in preparation or when no cutter is at hand, the dough may be made somewhat softer than above and dropped on the tin by spoonfuls about one-half inch apart. The mixture, although soft, should be stiff enough not to spread on the tin, yet soft enough so that the biscuits when baked have a smooth, rounded surface rather than a rough, lumpy one. If desired, the top may be brushed with milk or smoothed gently with a knife dipped into water or milk. Bake as above.

These "emergency" or drop biscuits are not quite like the rolled ones, yet if of the proper consistency they are equally good. Indeed some excellent judges of pastry insist that they are always a little more tender.

SOUR-MILK BISCUIT.

(12 biscuits.)

- | | |
|-------------------------|--------------------------------------|
| 2½ cups sifted flour. | 1 teaspoon baking powder. |
| ½ teaspoon salt. | 2 tablespoons shortening. |
| ½ teaspoon baking soda. | About ¾ cup sour milk or buttermilk. |

Sift together the flour, salt, baking powder, and soda. Cut or chop in the shortening, add the sour milk, and mix as usual. Bake thoroughly in a hot oven about 10 to 12 minutes. Be sure that the milk is sufficiently sour to neutralize *all* the soda.

If desired, a drop biscuit may be made, using about one cup of the sour milk for mixing and one-half teaspoon soda.

WHOLE-WHEAT BISCUIT.

(10 biscuits.)

- | | |
|---|--------------------------------|
| 2 cups graham flour (or homeground wheat meal) measured before sifting. | 2½ teaspoons baking powder. |
| ½ teaspoon salt. | 1 or 2 tablespoons sweetening. |
| | 2 tablespoons shortening. |
| | ¾ to 1 cup liquid. |

Mix as directed under baking-powder biscuit, returning the bran to the mixture after sifting and dissolving the sweetening (if used) in the liquid used for mixing. Roll slightly thinner than for plain biscuit and bake a little more slowly and thoroughly.

PEANUT BISCUIT.

Follow directions for plain baking-powder biscuit given on page 22, but add to the sifted mixture ½ to 1 cup of peanut meats, chopped or rolled fine. The addition of one or two teaspoons sweetening will improve the flavor of these biscuits.

PEANUT-BUTTER BISCUIT.

Replace all or part of the shortening in any of these recipes by peanut butter and proceed as usual. A little sugar, about 1 teaspoon, will improve the flavor.

POTATO BISCUIT.

(15 biscuits.)

- | | |
|----------------------------|---------------------------------------|
| 2 cups sifted flour. | 1 cup mashed potato (sweet or Irish). |
| 1 teaspoon salt. | 3 tablespoons shortening. |
| 3 teaspoons baking powder. | Liquid sufficient to mix. |

Sift together the flour, salt, and baking powder. Cut or rub into this the cold shortening. In the same way rub into this flour mixture the mashed potato. Finally, add just enough cold liquid to make the mass cling together. Do not knead. Place on floured board, roll until one-third inch thick, and cut into rounds. Place these in lightly floured biscuit tins and bake 15 to 20 minutes in a moderately hot oven. Bake all potato breads more slowly than those made with flour alone.

CORN-MEAL BISCUIT.

(10 to 12 biscuits.)

In recipe for plain biscuit use from ½ to 1 cup (scant) of cornmeal (measured before sifting) in place of an equal amount of flour and proceed as directed otherwise. Roll the dough slightly

thinner and bake the biscuits a little more slowly and thoroughly. If desired, the cornmeal may be scalded with a small amount of boiling water, $\frac{3}{4}$ cup boiling water to 1 cup of meal. Cover and let stand $\frac{1}{2}$ hour. Then proceed as directed for making potato biscuit.

Any other fine meal or flour may be used to replace part of the wheat flour in biscuit making.

SCORE CARD FOR HOT BISCUITS.

1. General appearance (shape, size and uniformity, color)	15
2. Lightness	10
3. Crust (depth and quality)	10
4. Crumb—color	5
5. Crumb—texture (tenderness, flakiness, grain)	20
6. Flavor—taste and odor	40
Total	100

MUFFINS AND GEMS.

PLAIN MUFFINS.

(15 small muffins.)

2 cups sifted flour.	1 tablespoon shortening (melted)
2 teaspoons baking powder.	1 egg.
$\frac{1}{2}$ teaspoon salt.	About 1 cup liquid (preferably milk)
1 tablespoon sweetening, if desired.	

Beat the egg until light, add a portion of the liquid and the sweetening if used. Mix this with the flour which has been sifted with the baking powder and salt. Add the melted shortening and sufficient liquid to make a smooth batter and beat well. Place mixture in greased muffin pans until about half full and bake 20 to 25 minutes in a moderate oven. If preferred, the white of the egg may be beaten separately and folded into the batter last.

WHOLE-WHEAT MUFFINS.

(15 small muffins.)

2 cups graham flour (measured before sifting) or part graham and part white flour.	1 or 2 tablespoons sweetening.
2 $\frac{1}{2}$ teaspoons baking powder.	1 tablespoon shortening (melted).
$\frac{1}{2}$ teaspoon salt.	1 egg.
	1 to 1 $\frac{1}{4}$ cups liquid.

Proceed as for making plain muffins, but add to the flour mixture the bran which remains after sifting the dry materials. A little more liquid is required for graham than for white flour. Bake longer and a little more slowly than plain muffins.

BRAN MUFFINS.

(12 muffins.)

1 cup flour.	$\frac{1}{4}$ to $\frac{1}{2}$ cup sweetening.
1 teaspoon salt.	1 tablespoon shortening (melted).
1 teaspoon soda.	1 $\frac{1}{2}$ to 2 cups sour milk.
2 cups clean bran.	$\frac{1}{2}$ cup seeded raisins or chopped nuts.

Sift together the flour, salt, and soda and mix with this the bran. Add together the sweetening, melted shortening, and part of the

milk; then mix with the dry materials. Add the raisins, dusted with flour and enough more sour milk to form a batter of such consistency that it will drop but not pour from the spoon but be as wet as possible otherwise. Bake in greased muffin pans about $\frac{1}{2}$ hour.

BRAN MUFFINS WITH BAKING POWDER.

(12 muffins.)

1 cup flour.	$\frac{1}{2}$ cup sweetening.
1 teaspoon salt.	1 egg.
3 teaspoons baking powder.	1 tablespoon shortening (melted).
2 cups clean bran.	About $1\frac{1}{2}$ cups sweet milk.

Sift together the flour, salt, and baking powder; blend with this the bran, and add to these dry ingredients the mixture of milk, beaten egg, sweetening, and shortening. Have a thick but very moist batter as described in preceding recipe for bran muffins. Bake in greased muffin pans in a moderate oven about $\frac{1}{2}$ hour.

THE USE OF CORN MEAL IN MUFFINS.

Various samples of corn meal differ greatly from each other not only in color but also in fineness of the particles, the presence or absence of noticeable portions of bran and germ, and the absorption of liquid.* Southern corn meal is usually a stone-ground product, soft, smooth, and white. It is generally unbolted, but sometimes has the larger part of the coarse bran and germ removed. The unbolted, stone-ground meal has a rich, distinctive flavor much enjoyed by all who are accustomed to it.

In the North a yellow corn meal is preferred, and in the milling steel rolls are used in place of burrstones. In this steel-roller process of milling the corn is generally kiln-dried, then degerminated, and the meal is bolted. The product is fine and sharp, and owing to the kiln-drying and removal of the germ it keeps better than the stone ground, although it lacks something of the rich flavor of the latter. It has been found that the steel-roller ground meal requires about 10 per cent more liquid for cooking than the stone ground.

The roller-process meal, since it is both degerminated and bolted, is less rich in fat, in mineral ingredients, and in fibrous material than unbolted stone-ground meal.

CORN MUFFINS—SOUTHERN STYLE.

(15 small muffins.)

2 cups corn meal (measured before sifting).	1 egg.
$\frac{1}{4}$ teaspoon baking soda.	1 tablespoon shortening (melted).
$\frac{1}{4}$ teaspoon salt.	$1\frac{1}{2}$ to 2 cups sour milk or buttermilk.

Proceed as directed for whole-wheat muffins.

CORN-MEAL STICKS.

The batter for corn-meal muffins may also be baked in the iron bread-stick pans. Have the pans greased and sizzling hot; place one

* See Farmers' Bul. 565, Cornmeal as a Food and Ways of Using It, p. 8.

good spoonful in each depression so that the latter is about two-thirds full; smooth the top of the mixture with a knife, if necessary, and bake in a rather quick oven about 25 minutes. Since they have a large proportion of crisp crust and comparatively little crumb, these cornsticks are liked by many who do not otherwise care for breads made entirely of corn meal.

If a corn-meal muffin of larger bulk and less granular in texture be desired, some wheat flour must be added to the meal, since mixtures made with corn meal alone do not rise as much as wheat-flour doughs. If in the recipe for corn-meal muffins—southern style, one-third or one-half of the meal were replaced by wheat flour, a noticeably larger and more porous muffin would result.

CORN MEAL AND WHEAT-FLOUR MUFFINS.

(15 small muffins.)

1 cup corn meal (measured before sifting).	1 tablespoon sweetening (more if desired).
1 cup wheat flour.	1 egg.
$\frac{3}{4}$ teaspoon salt.	1 tablespoon shortening (melted).
$2\frac{1}{2}$ teaspoons baking powder.	About 1 cup milk.

Mix and bake as directed for whole-wheat muffins.

In a number of the Southern States soy beans or peanut flour may be obtained which is made by grinding the press cake left after expressing most of the oil from soy beans or peanuts. These flours are very nutritious, and when mixed with an equal amount or more of wheat flour, produce rich and appetizing breads. If the peanut flour be lightly browned or parched in the oven before using, it will yield a product of better flavor.

If these flours can not be purchased, the housewife may prepare the meals herself. Clean, dry soy beans may be ground in an ordinary food chopper or hand mill such as is used for preparing chicken feed. The coarse bran should be sifted out and the remaining meal ground to the desired fineness. The Mammoth Yellow or Haberlandt varieties of soy bean are especially desirable for this purpose.

Peanuts may be shelled, parched, and crushed with a rolling-pin or ground in a food chopper until reduced to a meal. This meal is delicious in muffins, bread, cookies, and in numerous other articles of food.

SOY-BEAN MUFFINS.

(15 small muffins.)

1 scant cup soy bean meal or flour.	1 or 2 tablespoons sweetening.
1 cup wheat flour.	1 tablespoon shortening (melted).
$\frac{3}{4}$ teaspoon salt.	1 egg.
$2\frac{1}{2}$ teaspoons baking powder.	About 1 cup liquid.
$\frac{1}{2}$ cup raisins, or chopped dates, if desired.	

Blend the materials as directed for plain muffins, adding the fruit previously dusted with flour. Do not have this batter too soft, as it does not thicken as much in baking as that made with other flours.

PEANUT-FLOUR MUFFINS.

Proceed as for soy-bean muffins, using peanut flour in place of soy-bean meal or flour. The raisins or dates are a very agreeable addition although not necessary. Peanut butter may well be used as the shortening.

CORN-FLOUR MUFFINS.

If corn flour can be purchased, follow the directions for soy-bean muffins, using corn flour in place of soy-bean meal. The sweetening may be omitted. If desired, 2 tablespoons of shortening may be used in these.

BUCKWHEAT MUFFINS.

Any of the grains such as rye, buckwheat, barley, finely-ground oats, feterita, kafir corn, or milo maize, etc., in the form of meal or flour, may be used in place of the soy-bean meal in the recipe for soy-bean muffins. The raisins may be added or omitted as desired.



FIG. 5.—Potato muffins.

POTATO MUFFINS.

(12 to 15 muffins.)

- | | |
|--|--|
| 1½ cups wheat flour. | 1 or 2 eggs. |
| ¾ teaspoon salt. | 2 tablespoons shortening. |
| 3 teaspoons baking powder. | Liquid sufficient to make a rather stiff |
| 1 cup cooked sweet potato (Irish "potatoes may be used instead). | batter (about ½ cup). |

Boil the potatoes in the skins until tender; drain, peel, and mash fine. Putting the potato through a ricer or colander is better than

mashing. Sift together the flour, salt, and baking powder. Beat the eggs until light and add to the cool mashed potato. Next add the melted shortening, then the flour mixture, alternating with portions of the liquid, until a batter is formed somewhat stiffer than for ordinary flour muffins. Drop by spoonfuls into greased muffin pans until half filled and bake about 30 minutes in a moderately hot oven.

RICE MUFFINS.

Substitute cooked rice for the cooked potato in the recipe for potato muffins.

• Cooked breakfast cereals, such as very thick oatmeal or corn-meal mush, cooked soy-bean meal, cooked or baked dasheen, may be used in place of the mashed potato in the recipe for potato muffins. Unless the oatmeal mush be very thick it would be better to use of this $\frac{1}{2}$ to $\frac{3}{4}$ cup instead of 1 cup, as directed for potato, rice, etc.

CORN MEAL-POTATO MUFFINS.

(12 small muffins.)

1 cup corn meal.	1 tablespoon shortening (melted).
$\frac{1}{2}$ teaspoon salt.	1 or 2 eggs.
3 teaspoons baking powder.	$\frac{1}{2}$ cup liquid or more (enough to make
1 cup mashed potato.	a medium soft batter).
1 tablespoon sweetening, if desired.	

Mix as usual and bake very thoroughly one-half hour.

CORN MEAL-RICE MUFFINS.

One cup of cooked rice may be used in place of the mashed potato in the recipe for corn meal-potato muffins.

BREAD MUFFINS.

(10 small muffins.)

$1\frac{1}{2}$ cups dry bread crumbs.	1 tablespoon shortening.
1 cup milk.	1 or 2 tablespoons sweetening.
$\frac{1}{2}$ teaspoon salt.	$\frac{1}{2}$ cup flour.
1 egg.	2 teaspoons baking powder.

Scald the milk, add the crumbs, allow to stand 15 minutes, then mash and beat to a paste. Add the salt, beaten egg yolk, melted shortening, sweetening, and the flour and baking powder sifted together. Finally, fold in the beaten egg white. Pour into gem pans until half filled, then bake about 20 minutes in a moderately hot oven.

SCORE CARD FOR MUFFINS.

Although the characteristics of muffins are different from those of hot biscuits, the points to be scored are practically identical. The same score card may therefore be used for both, with one difference: Under texture for biscuits there are the terms "tenderness, flakiness, and grain"; under texture for muffins use the terms "tenderness, crumbliness, and grain."

CORN MEAL-PUMPKIN DODGERS.

(10 to 12 cakes.)

- | | |
|---------------------------|--------------------------------|
| 1½ cups cooked pumpkin. | 1 or 2 tablespoons sweetening. |
| 1 teaspoon salt. | 1½ cups cornmeal. |
| 3 tablespoons shortening. | |

To the pumpkin, which has been cooked very tender and mashed free from lumps, add the salt, sweetening, melted shortening, and corn meal, and mix thoroughly. Have the mixture just soft enough to take up by spoonfuls and pat into flat cakes in the hand. Place on a griddle or greased baking sheet and bake about 20 minutes in a hot oven.

If desired, the corn meal may be added to the hot pumpkin and allowed to steam with the latter for 10 minutes before adding the other ingredients.

SWEET POTATO-CORN MEAL DODGERS.

Substitute sweet potato for the pumpkin in the preceding recipe.

EGGLESS CORN BREAD.

(12 servings.)

- | | |
|--|---------------------------------------|
| 2 cups corn meal. | ½ teaspoon baking soda, 1½ to 1¾ cups |
| 1 teaspoon salt. | sour milk. |
| 3 teaspoons baking powder, 1 cup sweet | 1 or 2 tablespoons sweetening, if de- |
| milk, or | sired. |
| | 2 tablespoons shortening. |

Sift together the corn meal, salt, baking powder (or soda). Dissolve the sweetening in the milk and add this to the sifted dry ingredients. Finally, add the melted shortening, beat well, and pour into a greased shallow tin. Bake 25 to 30 minutes in a moderately hot oven. Some wheat flour may be used in place of part of the corn meal if desired.

BATTER OR SPOON BREAD.

(Serves six.)

- | | |
|--------------------------|---------------|
| 1 cup corn meal. | 2 cups water. |
| 1 teaspoon salt. | 2 eggs. |
| 1 tablespoon shortening. | 1 cup milk. |

Place the meal, salt, shortening, and water in a double boiler and cook 10 minutes, stirring until smooth and thick. Allow to cool somewhat, then add the well-beaten eggs, and finally thin down to a batter with about one cup of milk. Beat well, pour into a greased pan or baking dish, and bake in a rather hot oven about 30 minutes.

BOSTON BROWN BREAD.

(3 small loaves.)

- | | |
|----------------------|-----------------------------------|
| 2 cups graham flour. | ½ cup sirup or molasses. |
| 1 cup corn meal. | 1½ to 2 cups sour milk. |
| 1 teaspoon salt. | 1 tablespoon shortening (melted). |
| 1 teaspoon soda. | ½ cup seeded raisins. |

Sift together the dry materials, returning the bran to the flour mixture. Add together the sweetening, shortening, and $1\frac{1}{2}$ cups of sour milk (or buttermilk) and blend with the flour mixture to which the raisins have been added. If necessary, add a little more milk until a thick batter is formed. Beat well and place in greased tins, such as coffee or baking-powder cans, filling not more than two-thirds full. Place cover on cans and steam three hours. It is excellent when baked about five hours in a fireless cooker, especially when a hot radiator is used to keep the heat at sufficiently high pitch. If no radiator is used, the bread should be steamed one hour before putting into the fireless.

Rye flour, rye meal, or home-ground wheat meal may be used in place of graham flour.

In place of sour milk and soda one may use $1\frac{1}{2}$ cups of sweet milk and 3 teaspoons of baking powder. If molasses is used, $\frac{1}{4}$ teaspoon of soda should be added to neutralize the acid therein.

GRIDDLE CAKES AND THE LIKE.

CORN MEAL GRIDDLE CAKES.

(Serves six.)

$1\frac{1}{2}$ cups corn meal.	1 tablespoon shortening (melted).
1 cup boiling water.	1 teaspoon baking soda.
$\frac{3}{4}$ teaspoon salt.	1 egg.
1 or 2 tablespoons sweetening, if desired.	2 cups sour milk.
	$\frac{1}{2}$ cup wheat flour.

Scald the meal with the boiling water in which has been dissolved the salt; cover and allow to cool. When quite cool add to it the sweetening (if used), the shortening, the well-beaten egg, and part of the milk. Blend with this mixture the flour and soda sifted together and the remainder of the milk, or enough to make a batter which will pour easily but is not too thin. Beat thoroughly and bake on a hot griddle until well browned on both sides.

In place of sour milk and soda one may use sweet milk (or part water) and 3 teaspoons of baking powder.

POTATO-CORN MEAL GRIDDLE CAKES.

(Serves six.)

1 cup mashed potato.	1 egg.
1 cup corn meal.	$\frac{1}{2}$ cup flour.
1 teaspoon salt.	$2\frac{1}{2}$ teaspoons baking powder.
1 or 2 tablespoons sweetening.	About 1 cup liquid.
1 tablespoon shortening (melted).	

Add the salt, sweetening, and one-half cup milk or water to the mashed potato, then blend with this the corn meal. Heat and stir frequently until the meal is scalded or cooked for about 5 minutes. Remove from the fire and cool. When cold add to this mixture the shortening, the well-beaten egg, the flour and baking powder sifted

together, and enough liquid (milk or water) to make a batter which will pour easily but is not too thin. Bake slowly and thoroughly on a hot griddle.

BREAD GRIDDLE CAKES.

(Serves five.)

1½ cups dry bread crumbs.	1 tablespoon shortening.
1½ cups sweet milk.	1 egg.
½ teaspoon salt.	½ cup flour.
1 or 2 tablespoons sweetening, if desired.	2 teaspoons baking powder.

Scald the milk, add the crumbs, let stand 15 minutes, then mash and beat to a paste. Add the salt, sweetening, melted shortening, and well-beaten egg. Finally, add the flour and baking powder, which have been sifted together. Bake on a hot griddle until nicely browned on both sides.

In place of baking powder and sweet milk alone, one-half cup sweet milk may be used to moisten the crumbs and 1 cup of sour milk with one-half teaspoon baking soda for thinning and leavening the mixture.

WAFFLES.

(Serves four.)

2 cups sifted flour.	2 eggs.
3 teaspoons baking powder.	1 tablespoon shortening (melted).
½ teaspoon salt.	1 cup milk (or more).
2 teaspoons sugar, if desired.	

Sift together the flour, baking powder, salt, and sugar. Beat the eggs until light, separating whites and yolks if desired. To the beaten eggs (or yolks) add the shortening and part of the milk, and mix this with the dry materials. Beat thoroughly and add enough more milk (or water) to make a smooth batter about the consistency of thick cream. If the whites were beaten separately, fold them in last.

The waffle irons should be thoroughly clean and smooth. Heat both sides thoroughly and grease with a brush or swab dipped in liquid fat, or rub the iron with a piece of fat bacon rind. Place a spoonful of batter in each compartment of the griddle, near the center, close the irons and the batter will fill the compartments. Bake on one side until the edges seem to be browning, then turn the iron and bake the other side until delicately brown.

CORN-MEAL WAFFLES.

In recipe for plain waffles use 1 scant cup corn meal and 1 cup wheat flour in place of all wheat flour. Proceed otherwise as directed there. These waffles are especially crisp and delicate.

RICE WAFFLES.

(Serves four.)

1 cup sifted flour.	1 cup cooked rice.
3 teaspoons baking powder.	2 eggs.
$\frac{1}{2}$ teaspoon salt.	1 tablespoon shortening (melted).
2 teaspoons sugar, if desired.	About $\frac{1}{2}$ cup milk.

Cook the rice until very soft and while hot mash it to a pulp. When cool add to it the melted shortening, the beaten egg yolks, and $\frac{1}{2}$ cup of milk. Add to this the flour which has been sifted with the baking powder, salt, and sugar. Beat thoroughly and lastly fold in the stiffly beaten egg whites. If necessary, add more milk to make a batter which will pour easily.

It is not necessary in making waffles to separate the whites and yolks of the eggs.

STRAWBERRY SHORTCAKE.

(Serves five.)

2 cups sifted flour.	4 tablespoons shortening (preferably butter or butter substitute).
3 teaspoons baking powder.	About $\frac{3}{4}$ cup milk or 1 or 2 tablespoons less of water.
$\frac{1}{2}$ teaspoon salt.	
1 tablespoon sugar.	

Sift together the flour, baking powder, salt, and sugar. Cut in the shortening and mix lightly with milk or water until like biscuit dough. Divide into two equal portions and roll each into a sheet about $\frac{1}{4}$ inch thick. Bake in shallow pan, one sheet upon the other, after spreading the lower lightly with butter. Or, cut the dough, after rolling, into rounds as for biscuit, placing two rounds upon each other separated by a thin layer of butter.

After baking in a rather hot oven about 15 minutes, separate the two layers. Spread each with butter and well-sweetened berries. Serve with whipped cream.

Other fruits, such as fresh red raspberries, dewberries, sliced peaches, oranges, stewed dried fruits, or stewed rhubarb, are excellent for shortcake.

VARIATIONS OF BISCUIT DOUGH.

As will be noticed, the recipe for shortcake is merely a variation of plain biscuit dough, having a larger amount of shortening and the addition of a small amount of sugar. Still other variations may be made.

PIN WHEELS.

Use baking-powder biscuit recipe with addition of 2 tablespoons sugar and an extra tablespoon of flour if needed. Roll to $\frac{1}{4}$ inch thickness. Brush over with melted butter and sprinkle with fruit (currants, raisins, or citron), or with cinnamon and sugar alone. Roll like a jelly roll and cut off pieces $\frac{1}{2}$ inch in thickness. Bake same as biscuits.

COFFEE CAKE.

In the recipe for plain biscuits add 2 tablespoons of sugar to the dry ingredients and one egg, well-beaten, to the liquid and mix as usual. Roll or pat into a sheet $\frac{1}{2}$ inch thick and place in greased pan. Dot top with bits of butter and strew with sugar and a little cinnamon. Bake in rather hot oven. This dough may be baked in two sheets and used for shortcake, making a somewhat richer cake.

DUTCH APPLE CAKE.

Prepare dough same as for coffee cake. After placing in pan, cover top with tart apples sliced $\frac{1}{4}$ inch thick, set close together and slightly overlapping. Strew generously with sugar, dust with cinnamon, and dot with bits of butter. Bake in a moderate oven until apples are very tender.

Other fruits such as sliced peaches, plums, raspberries, cherries, and stewed dried fruits may be used in place of the apples in this recipe.

PASTRY.

PLAIN PIE CRUST.

(Two crusts.)

1 $\frac{1}{2}$ cups sifted flour.	| 6 tablespoons shortening.
$\frac{1}{2}$ teaspoon salt.	
$\frac{1}{2}$ teaspoon baking powder, if desired.	
	| Cold water to mix.

Sift together the flour, salt, and baking powder (if used). Reserve 1 tablespoon of shortening until later, and cut or chop the remainder of the cold shortening into the flour until the mixture is like meal. Mix with water as cold as possible until a rather stiff dough is formed. Divide the dough into two parts, rolling the first and fitting it into the greased or flour-dusted pie tin. Do not stretch the dough when placing it in the pan as it shrinks in baking.

Roll the dough for the upper crust into a long sheet and spread lightly with the tablespoonful of shortening which was reserved. Dust with flour, fold the dough into thirds, and roll into shape. Fold over in the middle and slash several times at the fold. Open out the sheet, fold over crosswise, and slash again at the fold. Then place on the pie. Trim closely to the plate and press top and lower crusts together. Bake in a hot oven.

Pastry is more flaky if chilled before rolling.

If the filling is very moist, it is better to bake the lower crust in a hot oven about 5 minutes, or until just beginning to color, before adding the filling.

The following recipe and directions for economical plain paste have been contributed by Dr. Minna C. Denton, Assistant Chief of the Office of Home Economics, Department of Agriculture.

ECONOMICAL PLAIN PASTE.

1½ cups sifted flour.
½ teaspoon salt.

4½ to 6 tablespoons fat.
3 tablespoons water.

Take out 2 or 3 tablespoons of this flour for use on board. Cut or chop shortening and salt into remainder of flour with knife or fork, using tips of fingers toward the close of the mixing process, if desired; work until the mixture is like meal. Make a well in center of mixture, pour in slowly 3 tablespoons of water, stir (or beat with back of spoon) into a mass or loose ball which can be turned out on to a lightly floured board.

(Do not use more than 3 tablespoons water, for that will make your pie crust tough when so small an amount of fat is used. An extra tablespoonful of water will harden this crust, especially if you are using a hard-winter or spring-wheat flour.)

Divide paste into two portions, the one for the lower crust being a little more than half of the whole mass; since the lower crust needs to be thicker than the upper, in order to hold firm. Roll the larger to fit the pie tin, being careful not to stretch or knead the dough, nor handle it more than is absolutely necessary. Fit into the pie tin and add filling. Roll upper crust, cut several holes for escape of steam, place on pie, trim at edge of plate, press edges of two crusts together. Bake in hot oven, about 35 minutes, reducing the heat somewhat in the latter half of the baking period.

This paste, if properly handled, even with only 4½ tablespoons fat, makes a fairly tender crust which is quite satisfactory for apple, chocolate, lemon, peach, or mince pie; in short, for all except the very juicy pies such as cherry, rhubarb, and berries. These juicy fillings are better if baked in a richer crust, made with 6 or 7 tablespoons of fat to 1½ cups of flour. Three tablespoons of water for mixing the paste will be found sufficient in each of these cases, when once you become accustomed to handling paste made with little water. As the amount of fat is increased, however, a slight increase in the amount of water used does not do so much harm; the excess water is less likely to toughen the crust when there is plenty of fat.

This paste should be quickly and lightly mixed. It is not necessary that the ingredients be cold in crusts containing small amounts of fat. Both fat and water may be warm or even hot; in fact, some workers prefer to use melted fat. However, the crusts made with hot water or melted fat will be mealy rather than flaky, especially when much fat is used. Yet these mealy crusts are often tender and good.

Crusts in which 5 tablespoons of fat or more are used to the cup of flour should be thoroughly chilled. Any fat which is bland or tasteless or agreeable in flavor may be used, as lard, vegetable lards, and vegetable oils. However, do not use more than 4 tablespoons oil

to the cup of flour. Any wheat flour may be used, either bread or pastry, though the results are a little different in the two cases. It is easier to handle pastry flour with a small amount of fat and water than it is to similarly handle bread flour.

If the pie tin is a small one, only 7 or 8 inches in diameter, 1 cup of flour will be sufficient for 2 crusts and will require 3 or 4 tablespoons of fat and 2 tablespoons of water. If it is of generous size (over 9 inches), use $1\frac{3}{4}$ cups of flour with 5 or 6 tablespoons of fat and 3 tablespoons of water, or a very little more.

APPLE PIE.

Line a pie tin with pastry and fill with thinly sliced tart apples. Strew generously with sugar, $\frac{1}{4}$ to $\frac{1}{2}$ cup, dust lightly with cinnamon and nutmeg if desired, and dot with bits of butter. If the apples are very dry they may be plunged into boiling water before placing in the pie, or 2 tablespoons of water may be poured over the apples. Cover with top crust and place in a hot oven for 5 to 10 minutes. When the crust begins to color slightly, reduce the temperature and continue the baking at a moderate temperature until the apples are very tender, about 35 minutes in all.

CHOCOLATE CREAM PIE.

(Serves five or six.)

Prepare filling from following:

2 cups milk.	2 ounces grated chocolate (or 4 table-
$\frac{1}{2}$ teaspoon salt.	spoons powdered cocoa).
$\frac{1}{2}$ cup sugar.	2 egg yolks.
4 tablespoons cornstarch.	1 teaspoon vanilla.
	2 egg whites for meringue.

Cook until thick enough to pile. Prepare a single crust for this pie by rolling the dough for it on the outside of an inverted pie tin which has been lightly dusted with flour beforehand. When baked for 5 minutes this shell may be slipped off and placed inside the pie tin, ready for the filling. This is a good way to prepare a perfectly smooth and well-fitting lower crust for pies which are to hold liquid or semiliquid fillings. Add the filling. Place in hot oven until filling just bubbles. Remove from the oven and spread over the pie the stiffly beaten egg whites mixed with 2 to 3 tablespoons sugar. Return to the oven until the meringue is delicately browned on top.

SWEET-POTATO PIE.

(Serves five or six.)

2 cups cooked sweet potato.	1 to 2 cups milk.
$\frac{1}{2}$ teaspoon salt.	Spice to taste, or
$\frac{1}{2}$ cup brown sugar, or	$\frac{1}{2}$ teaspoon cinnamon.
$\frac{1}{2}$ cup sirup or molasses.	$\frac{1}{2}$ teaspoon allspice.
2 eggs.	$\frac{1}{2}$ teaspoon cloves.
1 tablespoon butter (melted).	

Mash the potatoes or put through a ricer while hot. Add the salt, sweetening, the spice, melted shortening, the well-beaten eggs, and milk enough to make a smooth batter not too thin. Bake a single crust lightly, add the filling, and put back into the oven until crust is thoroughly baked.

SQUASH PIE.

Cooked Hubbard squash may be used in place of the sweet potato in the preceding recipe.

USES FOR LEFT-OVER PASTRY.

In the making of pies a small portion of dough, insufficient for another pie, is frequently left over. This may be utilized in various ways as follows:



FIG. 6.—Pastry crisps with sugar and cinnamon.

PASTRY CRISPS.

The dough may be simply rolled thin, cut into squares, sprinkled with sugar and cinnamon, and baked until crisp. These are very nice to serve with sauce or other dessert, and are more economical of time and money than are most cookies or cake.

ROLY-POLY.

Roll pastry until about $\frac{1}{4}$ inch in thickness, cover with dried currants or with fresh blackberries, raspberries, or blueberries well sweetened, sprinkle with flour, and then roll like a jelly roll. Bake in a moderately hot oven until well done. Serve with liquid sauce.

CHEESE STRAWS.

Roll pastry thin, cover with grated cheese or with a highly seasoned soft cheese; fold into thirds and roll again into a thin, long sheet. Cut into narrow strips and bake in a hot oven until delicately browned. These are nice to serve with salads.

PASTRY SHELLS.

Bake pastry in or on the outside of muffin pans and fill these shells with jam, preserves, or well-sweetened stewed fruit. With or without the addition of whipped cream these form a delicious dessert.

These shells may be filled with creamed chicken, creamed peas, etc., adding an attractive dish for another meal.

COOKIES.

PLAIN ROLLED COOKIES.

(About 60 cakes.)

1 cup sugar.
 $\frac{1}{2}$ cup shortening.
 1 egg.
 1 teaspoon flavoring extract.

3 cups sifted flour.
 2 teaspoons baking powder.
 $\frac{1}{2}$ teaspoon salt.
 About $\frac{1}{2}$ cup milk.

Cream together the sugar and shortening; add to this the well-beaten egg, the flavoring extract, and the flour, sifted together with the salt and baking powder. Add sufficient milk (or water) to form a dough just stiff enough to roll on the board without sticking. Roll thin, from $\frac{1}{8}$ to $\frac{1}{4}$ inch in thickness, and cut into desired shape. Bake in a rather hot oven until delicately browned, about 10 to 12 minutes.



FIG. 7.—Individual pastry shells as a dessert. These shells make left-over sweets or creamed meats and vegetables go farther.

PLAIN DROP COOKIES.

Add enough liquid in preceding recipe to make a dough which will barely drop from the spoon but which will spread slightly and form a smooth cookie. The dough should not be so soft, however, that the cookies lose their shape and spread over the entire pan. Drop by spoonfuls onto a greased baking sheet and bake in a moderately hot oven about 15 minutes.

SPICE COOKIES.

In the recipe for plain rolled or plain drop cookies omit the flavoring extract and sift with the flour 2 teaspoons cinnamon, 1 teaspoon allspice, and $\frac{1}{2}$ teaspoon cloves, or 1 tablespoon ginger and 2 teaspoons cinnamon.

CHOCOLATE COOKIES.

In recipe for plain cookies add 2 ounces chocolate (melted) or 4 tablespoons powdered cocoa, with 1 teaspoon vanilla extract.

RAISIN OR NUT DROP COOKIES.

In recipe for plain drop cookies add $\frac{1}{4}$ cup seeded raisins or $\frac{1}{4}$ cup chopped nuts dredged with flour.

RICH COOKIES.

1 cup sugar.	2 $\frac{1}{4}$ cups flour.
$\frac{1}{2}$ cup butter.	2 teaspoons baking powder.
2 eggs.	$\frac{1}{2}$ teaspoon salt.
1 tablespoon water.	Spice or flavor to suit taste.

Mix as directed for plain cookies. This dough will be about the consistency for drop cookies. If a rolled cookie is desired, omit the water and use 3 cups of flour or enough to make a dough stiff enough to roll thin. Cut and bake as usual. Dried fruits, nuts, etc., may be added if desired.

MOLASSES COOKIES.

(About 60 cakes.)

1 cup molasses.	1 teaspoon baking powder.
$\frac{1}{2}$ cup sugar.	$\frac{1}{2}$ teaspoon soda.
$\frac{1}{2}$ cup butter or butter substitute.	2 teaspoons ginger.
1 egg.	2 teaspoons cinnamon.
About 3 cups flour (more if necessary).	1 teaspoon allspice.
$\frac{1}{2}$ teaspoon salt.	

Cream together the sugar, shortening, and molasses and add the well-beaten egg. Sift together the flour, salt, baking powder, baking soda, and spice. Blend the dry ingredients with the molasses mixture. For rolled cookies have dough just stiff enough to roll on board without sticking. For drop cookies have the dough soft enough to barely drop from the spoon as directed for drop cookies.

In general these cookies will be more crisp if the molasses and shortening are heated together until the mixture just boils.

CORN-MEAL COOKIES.

(About 60 cakes.)

1 $\frac{1}{2}$ cups sifted flour.	$\frac{1}{2}$ cup sirup.
1 $\frac{1}{2}$ cups fine corn meal.	$\frac{1}{2}$ cup sugar.
$\frac{3}{4}$ teaspoon salt.	1 egg.
2 teaspoons baking powder.	1 teaspoon vanilla.
$\frac{1}{2}$ teaspoon soda.	Milk enough to mix.
$\frac{1}{2}$ cup shortening.	

Cream together the sugar, shortening, and sirup. Add the well-beaten egg, the vanilla, and the flour which has been sifted together with the corn meal, baking powder, salt, and soda. Add just enough milk to make a dough stiff enough to roll without sticking. Roll very thin, cut into desired shape, and bake in a moderately hot oven 10 to 12 minutes or until delicately browned.

PEANUT COOKIES.

(About 50 cakes.)

2 cups sifted flour.	$\frac{1}{2}$ cup shortening.
1 cup roasted peanut meats, blanched and crushed.	$\frac{1}{2}$ cup sirup.
$\frac{1}{2}$ teaspoon salt.	$\frac{1}{2}$ cup sugar.
2 teaspoons baking powder.	1 egg.
$\frac{1}{4}$ teaspoon soda.	Milk sufficient to mix.

Mix, roll, and bake as directed for corn-meal cookies. If desired, add milk enough to make a softer dough and drop by teaspoonfuls onto the greased baking sheet. Bake these drop cookies more slowly and a little longer than the rolled cookies.

COCONUT COOKIES.

In recipe for peanut cookies use shredded coconut in place of the crushed peanuts.

OATMEAL DROP CAKES.

(About 50 cakes.)

$\frac{1}{2}$ cup sirup.	1 cup sifted flour.
$\frac{1}{2}$ cup brown sugar.	$\frac{1}{2}$ teaspoon salt.
$\frac{1}{2}$ cup shortening.	2 teaspoons baking powder
1 egg.	$\frac{1}{2}$ cup seeded raisins.
2 cups rolled oats.	

Mix in the usual way and drop by teaspoonfuls onto a greased baking sheet 1 inch apart. Bake in a moderate oven about 15 minutes or until delicately browned.

OATMEAL MACAROONS.

(About 20 cakes.)

1 egg.	1 $\frac{1}{2}$ cups rolled oats.
$\frac{1}{2}$ cup brown sugar (white may be used).	$\frac{1}{2}$ teaspoon baking powder.
1 tablespoon butter or butter substi- tute.	$\frac{1}{2}$ teaspoon salt.

Cream together the sugar and shortening, add the beaten egg yolk, the salt, rolled oats, and baking powder. Lastly, fold in the stiffly beaten egg white. Drop by teaspoonfuls on a greased baking sheet, about 1 inch apart, and smooth the top with a knife dipped in cold water. Bake in a rather hot oven until delicately browned. If desired, the egg may be beaten without separating yolk and white.

CHRISTMAS CAKES.

(60 cakes.)

1 cup of sugar.	2 teaspoons baking powder.
$\frac{3}{4}$ cup butter or butter substitute.	$\frac{1}{2}$ teaspoon salt.
2 eggs.	2 teaspoons cinnamon.
1 tablespoon water.	$\frac{3}{4}$ cup seeded raisins.
2 $\frac{1}{2}$ cups sifted flour.	$\frac{3}{4}$ cup chopped nuts.

Cream together the sugar and shortening; add the well-beaten eggs, the water, and the flour sifted together with the salt, baking powder, and cinnamon. Lastly, add the raisins and nuts well dusted with flour. Mix thoroughly and drop by teaspoonfuls on a greased baking sheet about 1 inch apart. Bake in a moderate oven 15 to 20 minutes or until delicately browned.



(a)



(b)

FIG 8.—(a) Simple cookies decorated with raisins and sugar. (b) Simple cookies decorated with peanuts.

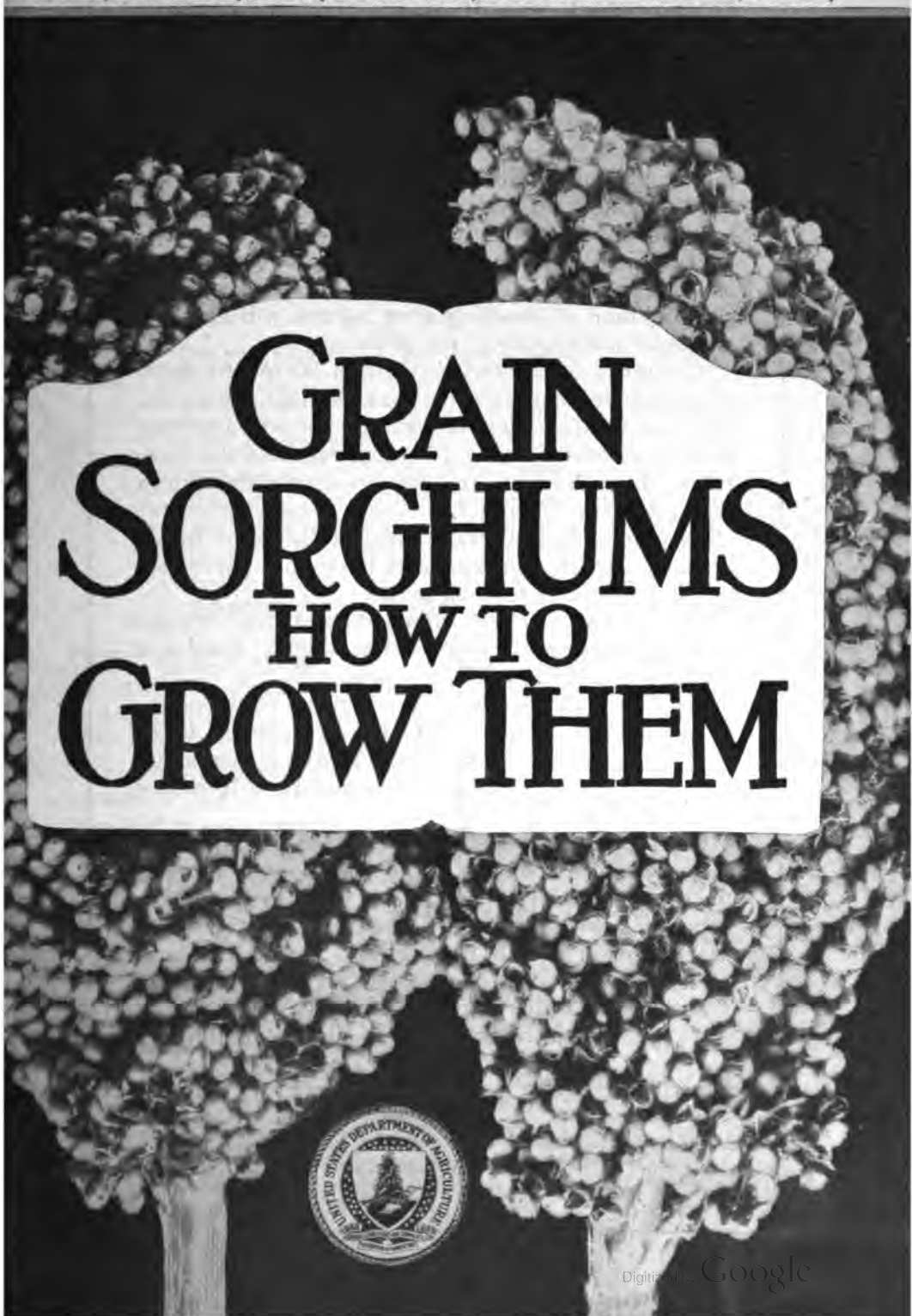
FANCY COOKIES.

It is a very simple matter to prepare fancy cookies. The top may be decorated by pressing onto it before baking a plump raisin or pieces of other dried fruit and dusting lightly with sugar. Ground nuts may be strewn over the top, or halves of nuts, such as pecans, English walnuts, peanuts, etc., be pressed onto the surface either singly or in form of a design.

Again, the cookies may be coated with a plain icing when they come from the oven and halves of nuts or fancy forms in the shape of stars, diamonds, etc., cut from fruit paste may be used to further decorate the cookies. The plain icing may be mixed with shredded coconut, ground nuts, or a mixture of nuts and dried fruits and spread on top or between two plain cookies. Marshmallow frosting, soft chocolate frosting, maple frosting, etc., may all be used as a filling between cookies. In fact, the housewife may imitate a number of the fancy cakes of the confectioner if she wishes to spend a little extra time and care on her baking.







GRAIN SORGHUMS HOW TO GROW THEM



THE GRAIN-SORGHUM CROP increased from approximately 2,000,000 acres in 1903 to 5,000,000 acres in 1919. The average acre yield varies from about 12 bushels in poor seasons to more than twice that quantity in favorable seasons.

The more important grain sorghums are included in two groups of varieties, the kafir group and the milo-durra group. Dwarf and early varieties in both groups are best for the higher and drier districts. The use of good seed of adapted varieties, a well-prepared seed bed, clean cultivation, and the right method of handling after harvest will increase the yield and quality of the grain.

The milos and feterita ripen in 90 to 110 days, which adapts them to short seasons, high elevations, and low rainfall. The kafirs are not so early and require more moisture. They do best when the rainfall is about 25 inches and the elevation ranges up to about 2,000 or 2,500 feet.

Pure seed is important. Select the seed heads from the standing stalks before the crop is harvested, so the best plants may be found.

These crops will grow on most soil types. It pays to delay sowing until the soil is warm. Cold soil injures germination and delays growth.

From 2 to 3 pounds of good, clean seed are required to sow an acre. On the average, 10 to 12 inches of row space to the plant in rows $3\frac{1}{2}$ feet apart is best for the milos and feterita and 14 to 16 inches for the kafirs.

Clean cultivation is essential for best results. Kill the weeds and keep the surface soil loose. Harvest the crop when it is ripe. Dry or cure the heads properly before thrashing and adjust the thrasher so that the grain will not be cracked. The grain should be clean and dry before it is stored in bulk; otherwise it will get out of condition quickly. While in storage it should be watched for signs of heating.

Contribution from the Bureau of Plant Industry

WM. A. TAYLOR, Chief

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GRAIN SORGHUMS: HOW TO GROW THEM

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IMPORTANCE OF THE GRAIN SORGHUMS.

THE ACREAGE devoted to the grain-sorghum crop shows a constant and substantial increase in the last 16 years. In 1903 this crop occupied about 2,000,000 acres, which was increased to 3,000,000 acres by 1911 and to more than 6,000,000 acres in 1918. The crop of 1919 was a little less than 5,000,000 acres. The exceedingly large acreage in 1918 was due in part to special effort to meet war conditions and in part to the need for replacing winterkilled wheat.

The yield varies considerably in different years. In 1915 an estimated total production of 114,460,000 bushels was obtained from 4,153,000 acres, or an average of 27.6 bushels to the acre. In 1916, the production from 3,944,000 acres was estimated at 53,858,000 bushels, or an average of only 13.7 bushels to the acre. The average acre yields from the crops of 1917 and 1918 were 11.9 and 11.8 bushels, respectively. The average acre yield of the crop of 1919 is estimated at about 25.8 bushels.

The variation in yield is due partly to seasonal conditions and partly to the methods employed in growing the crop. The high average acre yields in 1915 and in 1919 were produced under favorable conditions. In such seasons poor varieties as well as poor methods of growing the crop make fairly good yields. In unfavorable seasons, like those of 1916, 1917, and 1918, poor varieties and

poor methods of growing the crop result in failure. This accounts in a very large measure for the low average yields in those years. In very unfavorable seasons the best adapted varieties grown by the best methods often succeed while others fail. Earliness and dwarfness are two important factors in determining the varieties to grow in much of the grain-sorghum region. Early and dwarf varieties do better at high elevations, in short seasons, and under low rainfall than larger and later ones. Late varieties require long seasons and more moisture, though under favorable conditions they sometimes outyield the early dwarf varieties.

VARIETIES OF GRAIN SORGHUMS.

The sorghums commonly grown in this country may be divided naturally into three classes: (1) Sorgo, or saccharine sorghum; (2) grain sorghum, or nonsaccharine sorghum; and (3) broom corn. Each of these classes is made up of groups of varieties having some characteristics in common, and each class is grown for some particular purpose.

The sorgos, or saccharine sorghums, are marked by their tall stalks, which are full of sweet juice. The heads are quite variable in shape and color and usually do not produce heavy grain yields. The stalks are more valuable than the grain in this group of varieties, which are grown generally for forage and the production of sirup.

The broom corns are distinguished by their dry, pithy stalks and by their long, loose, open heads called brush. The heads, which are the important part of the crop, are used in making brooms and brushes.

The grain, or nonsaccharine sorghums, usually range in height from 3 to 6 feet. Some varieties in this class have dry, pithy stalks and short, narrow leaves. Others have broad leaves and juicy stalks, but the juice is usually slightly acid. All varieties in this class have large seed heads. The heads and kernels vary in shape, size, and color. This bulletin deals only with the more important varieties of grain sorghums.

The grain sorghums include several groups of varieties. The most important are the kafir and the milo-durra groups. Other groups of less importance are the kaoliangs and the shallus.

KAFIR GROUP.

The kafir group is marked by stout, short-jointed, leafy stalks. The leaves are broad, 12 to 16 or more in number, set close together on the lower half of the stalk but farther apart on the upper portion. The stalks are juicy, but the juice usually is not sweet like that of

the sorgo, or forage, group. However, one variety (Sunrise kafir) developed recently has a fairly sweet juice. The heads are cylindrical, 10 to 15 or more inches long. The ovoid seeds are of medium size and are about half covered by the short glumes or hulls. Heads of four varieties of kafir are shown in figure 1.

Six varieties of kafir are now grown commercially to some extent as grain crops in this country. These are the White, Blackhull, Dawn, Sunrise, Red, and Pink kafirs. Other varieties of less importance than these are sometimes grown in some localities.

WHITE KAFIR.

White kafir is one of two varieties of grain sorghum introduced from southeastern Africa in 1876. It is rather dwarf, from 3½ to 5 feet tall in the dry-land areas, and is the earliest of all kafir varieties. The heads are slender and the glumes and seeds are white. Its chief value is its earliness, the yield usually being low; hence this variety is not recommended, nor is it grown to any great extent now.



FIG. 1.—Heads of four varieties of kafir: A, White kafir; B, Guinea kafir (Guinea corn of the West Indies); C, Blackhull kafir; D, Red kafir. (About one-third natural size.)

BLACKHULL KAFIR.

Blackhull kafir appeared in this country shortly after White kafir. The stalks are stout and contain slightly acid juice. They usually grow to a height of 5 to 6 feet in the dry-land areas, and taller elsewhere. The leaves are 12 to 16 or more in number, 2 to 3 feet long and 3 to 5 inches wide. The heads are heavy, compact, 10 to 14 inches long, with black glumes, or hulls, and white seeds. This variety requires from 115 to 140 days to mature, depending on the locality and on seasonal conditions. It is not as early as White kafir, Dawn kafir,

or Sunrise kafir, and can not be ripened successfully at as high an elevation, in as short a season, or with as light a rainfall. However, it is the leading commercial variety. A plat of Blackhull kafir is shown in figure 2.

DAWN KAFIR.

Dawn kafir is a dwarf form developed by the United States Department of Agriculture from the Blackhull variety about 10 years ago. It grows only 3 to 4½ feet tall under dry-land conditions and matures from 10 to 14 days earlier than the ordinary Blackhull kafir. A plat of this variety is shown in figure 3.



FIG. 2.—A plat of Blackhull kafir (C. I. No. 71) on the experiment farm at Dalhart, Tex., August 31, 1911. Compare the stage of development with that of the Dawn kafir in figure 3, sown on the same day in an adjacent plat.

Dwarf stature and earliness are important characteristics in a reliable grain crop in the drier sections of the Great Plains area. These factors make possible the maturing of this variety under conditions where the ordinary Blackhull kafir fails. Dawn kafir is increasing in acreage and favor with the growers each year.

SUNRISE KAFIR.

Sunrise kafir was developed at the same time and from the same source as Dawn kafir. These two varieties differ mainly in the size, height, and sugar content of the stalks. Sunrise kafir has a slender stalk, which contains sweet juice and grows 5 to 7 feet tall under dry-

land conditions. Dawn kafir has a stouter and dwarfer stalk. Plats of these varieties are shown in figure 4.

Sunrise kafir is early and is a good grain producer. The sweet, leafy stalks and abundant grain make it a good silage variety. It appears to be increasing in favor with growers who desire a grain or silage crop.

RED KAFIR.

Red kafir was introduced from Africa at the same time (1876) as White kafir. In its requirements Red kafir is quite like the Blackhull variety. The leaves are slightly narrower and the heads are



FIG. 3.—A plat of Dawn kafir (C. I. No. 340) on the experiment farm at Dalhart, Tex., August 31, 1911. Compare its earliness with that of standard Blackhull kafir (fig. 2) sown on the same day.

longer and more slender than those of the Blackhull. The seeds are red and the glumes are dark red to black.

Red kafir was formerly grown to a greater extent than at present. It has been replaced by the Blackhull variety, because that variety has a wider adaptation and the yield usually is higher.

PINK KAFIR.

Recent introductions from South Africa have brought many new kafir forms. Some of these have seeds of various shades of pink, more or less intermediate between the white-seeded and red-seeded varieties. Several of the best of these have been introduced to cul-

tivation under the name Pink kafir, but they have not become commercially important.

A Pink kafir is now grown to some extent, mostly in Kansas, which makes fair yields under average conditions. Its origin is not known, though probably it is a natural cross between White kafir and Red kafir. It was found growing in Kansas about 12 years ago. This variety is fairly early, and resembles White kafir in manner of growth. The heads are much like those of Red kafir in length and shape, but the glumes are gray and the seeds are pale red or pink.



FIG. 4.—Dawn kafir (right) and Sunrise kafir (left) in plats at the Woodward (Okla.), Field Station, September 20, 1919.

MILO-DURRA GROUP.

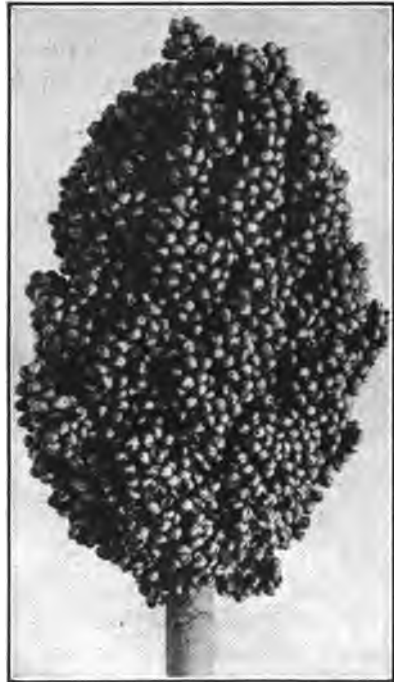
The common characters of the milo-durra group are slender, pithy stalks from 3 to 7 feet tall, bearing from 7 to 11 rather small leaves. The heads are large and compact, usually egg shaped, and are either erect or pendent. The glumes usually are black, but in some varieties are gray. The seeds are large, strongly flattened, either brown or white, and are one-third to one-half inclosed within the glumes.

Six varieties belonging to this group are grown commercially to some extent. These are Standard milo, Dwarf milo, White milo, Dwarf White milo, feterita, and White durra. These varieties mature in from 80 to 110 days under normal conditions in the drier sections of the southern Great Plains area. They can be grown with less moisture, in shorter seasons, and at higher altitudes than the

kafir varieties. They are therefore better adapted than those varieties to the uplands of western Kansas, western Oklahoma, and the Panhandle of Texas, where the average annual rainfall is 20 inches or less and where the elevation is 3,000 feet or more.

STANDARD MILO.

Milo was grown first in this country about 1882. It was not uniform in maturity and in height, most of the plants being tall. Standard milo is a direct descendant of the original type, reduced by systematic selection to a uniform height of from 5 to 6 feet under dry-land conditions in the southern Great Plains, where it is now grown to a large extent. This variety has 9 to 11 rather short and narrow leaves borne on a stalk which contains practically no juice. The heads are large, ovoid, and compact, and are either erect or pendent. The glumes are black and wrinkled crosswise. The large yellowish seeds are about one-third inclosed in the glumes. A typical head of milo is shown in figure 5.



DWARF MILO.

Dwarf milo closely resembles Standard milo, but grows only from 3 to 4 feet tall, depending on seasonal conditions. The comparative height of these varieties is shown in figure 6. Standard milo is from 18 inches to 2 feet taller than Dwarf milo when grown under the same conditions.

Dwarf milo makes up half or more than half of the acreage devoted to milo in this country. It usually produces a larger grain yield than the Standard variety and, because of its shorter stalks, can be harvested more satisfactorily with a grain header.

WHITE MILO.

White milo probably appeared in this country somewhat later than Standard milo. It differs from Standard milo in having white seeds, as the name indicates. The grain yields of this milo compare

favorably with those of Standard milo, but are not as large as the yields of Dwarf milo. The acreage of White milo is small and probably will remain so, as it has no advantage over Standard milo.

DWARF WHITE MILO.

Dwarf White milo bears the same relation to White milo as Dwarf milo does to Standard milo. This variety has been developed quite recently. A small acreage has been grown in the past few years, and some very good yields have been reported.

FETERITA.

Feterita is a native of Africa and is a leading variety in part of the Sudan region. It was introduced into this country in 1906. In



FIG. 6.—Milo (right) and Dwarf milo (left) in plats at the Amarillo (Tex.) Cereal Field Station, August 30, 1911.

habit feterita resembles milo, though the heads are always erect. Feterita heads are more elongated and the seeds are bluish white and slightly larger than those of milo. A plat of this variety is shown in figure 7.

Feterita requires about the same climatic conditions as milo. It appears to be able to stand a little more drought, but it does not respond to a plentiful supply of moisture as favorably as milo. Feterita sometimes produces a crop under drought conditions when milo practically fails. The acreage of feterita has increased to some extent in the past few years but is not nearly so large as that devoted to the milos.

WHITE DURRA.

White durra was among the first grain-sorghum varieties grown to any extent in this country. It was known as "White Egyptian corn" in California and as "Jerusalem corn" in Kansas and adjacent States. It has been almost entirely replaced by the more productive

varieties of kafir, milo, and feterita. California is practically the only State where White durra is grown now.

White durra has a slender stalk, which grows from 5 to 7 feet tall and bears from seven to nine small leaves. The stalk is dry, which, with the scanty foliage, makes it of little value for forage. The heads are large, egg shaped or oblong, and either erect or pendent. The glumes are greenish white and hairy, and cover about half of the large, strongly flattened, white seeds. When ripe the seeds shatter freely.

White durra is early, ripening in from 80 to 100 days, which makes its growth possible in short seasons. It is not naturally a heavy yielder under favorable conditions and, with its objectionable habit of



FIG. 7.—A plat of feterita (C. I. No. 182) at the Amarillo (Tex.) Cereal Field Station, September 28, 1915; yield, 55.5 bushels per acre.

shattering, is not a good variety to grow under conditions where more productive varieties are likely to mature.

OTHER GRAIN SORGHUMS.

The kaoliangs are natives of China and Manchuria, where they are cultivated extensively. Many varieties have been tested in this country, but so far none has proved of much value under our conditions. The kaoliangs have pithy stalks and short, narrow leaves, which make them of low fodder value. Their average grain yield is not as high as that from the better adapted varieties of kafir, milo, and feterita under the conditions obtaining in the southern Great Plains area. Some varieties are early and may be the means of adding

another grain crop in regions north of where kafir, milo, and feterita will mature.

Shallu is a late-maturing variety which has been widely advertised under several names and somewhat misrepresented. Under favorable conditions and a long growing season shallu makes fair yields. It is not a good variety to grow in most of the grain-sorghum belt. The yields are best in the extreme southern portion.

INCREASING THE YIELD AND QUALITY OF THE GRAIN.

The main steps in increasing the yield and quality of sorghum grain are as follows:

- (1) Grow adapted varieties.
- (2) Use pure seed of high vitality.
- (3) Prepare a good seed bed.
- (4) Sow the crop at the most favorable time.
- (5) Sow at a uniform depth, so that all the seeds come in contact with moist soil.
- (6) Use plates that will give the desired stand.
- (7) Cultivate the crop well, to prevent the growth of weeds, for weeds can not grow on the land at the same time without injury to the sorghum.
- (8) Harvest the crop as soon as it is ripe.
- (9) Let the crop get dry before thrashing.
- (10) Adjust the cylinder so that it will not crack the kernels.
- (11) Use the fanning mill to screen and blow out cracked kernels and dirt.
- (12) Store the clean grain in a dry well-ventilated bin or in bags.

THE VARIETY TO GROW.

Grow the variety of grain sorghum which is most likely to prove best in a series of years. No one variety will make the highest yield under all conditions. Where there is plenty of moisture and a long, warm growing season, the late-maturing Blackhull kafir usually yields more than any other variety. Under drier conditions and in shorter seasons the earlier varieties are surer and on the average outyield the later ones.

No fixed lines can be drawn showing just where each variety succeeds best. In general, the milos and feterita should be grown on the uplands, at elevations of 3,000 feet or more, and in the drier sections of the grain-sorghum belt. These varieties mature in fewer days and require less moisture than the kafirs. They usually give better results than the kafirs in localities where the average annual rainfall is 20 inches or less. The milos and feterita succeed well in southwestern Kansas, in the Panhandles of Oklahoma and Texas, in eastern Colorado, and in northeastern New Mexico. In southern Arizona and in California, where the crop is grown under irrigation, Dwarf milo usually outyields other varieties.

The kafirs are well adapted to localities which have an average annual rainfall of approximately 25 inches and an elevation up to

or slightly more than 2,500 feet. The bulk of the kafir crop should be grown east and south of the territory previously indicated for the milos and feterita. However, the kafirs do well in much of that territory in favorable seasons. The early kafirs, Dawn and Sunrise, are the best varieties to grow. The larger broad-leaved Black-hull kafir requires a longer season and more moisture than the early varieties. It should be grown farther east and south, at lower elevations and where the rainfall is greater.

SELECTING SEED.

Pure seed which germinates strongly is one of the chief factors in the production of large grain yields. Therefore care must be exercised in selecting the seed. This is essential not only as a means of improvement but also to prevent deterioration of the crops. Poor, off-type, low-yielding heads are always present, and the seed from such heads will be sown if the bulk grain thrashed from the entire crop is used.

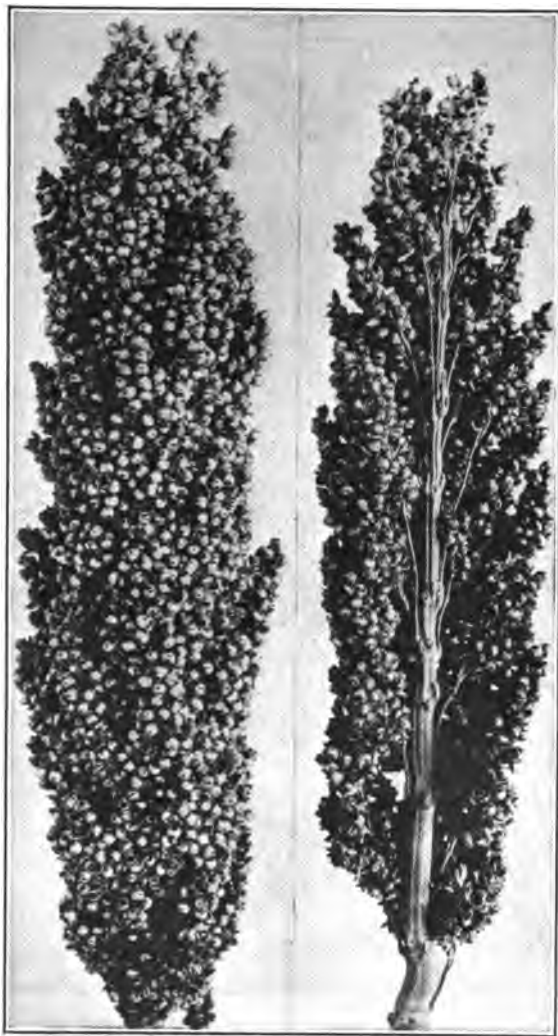


FIG. 8.—A good type of kafir head (left), showing inside construction (right).

The best seed obtainable should be used for sowing. From the resulting crop, seed heads should be selected for sowing the next year. Through continuous systematic selection from year to year it is possible to make substantial improvements in the uniformity of the plants and heads and to increase the yield and quality of the grain.

THE HEADS TO SELECT.

Select the heads which in size and shape, color of the glumes, and size and color of the seeds are true to the variety. Good types of kafir and milo heads are shown in figures 8 and 9. The unusually large off-type heads which always can be found in grain-sorghum

fields should not be gathered for seed. These heads are from hybrids resulting from the crossing of varieties and will not breed true to type. The sorghums are open pollinated and cross readily under field conditions when two or more varieties are grown close together.

Uniformity must be the watchword in making head selections if the quality of the crop is to be maintained or improved. The best type to grow should be determined and selections then made to that type. The main points to be observed in making head selections are: (1) Uniformity in height of the plants; (2) uniformity in shape and size of the heads; (3) uniform-

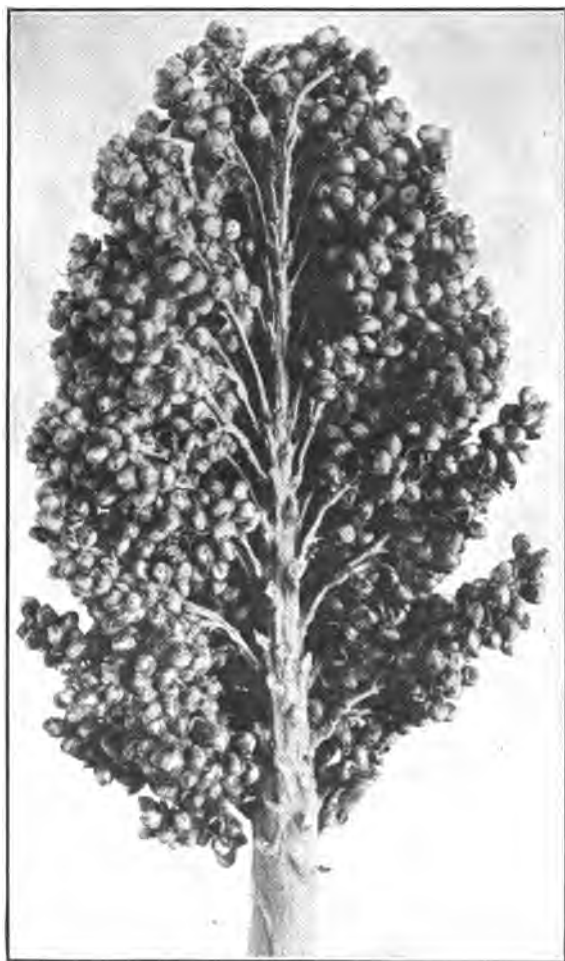


FIG. 9.—Inside construction of a typical head of milo.

ity in ripening; (4) uniformity in productiveness; and (5) in the milos and durra, uniformity in erectness of heads. In this group erect heads should be chosen in preference to pendent heads, other things being equal.

Where dwarf varieties are preferable the plants from which the heads are selected should be of a uniformly low stature, because a crop of uniform and comparatively short stalks usually makes a

better grain yield and is much easier to harvest either by hand or by machinery than a crop of tall nonuniform stalks. Neither is the crop of dwarf stature so likely to lodge as the tall one if windstorms occur.

WHEN TO MAKE HEAD SELECTIONS.

The seed heads must be selected before the main crop is harvested. This work should be done at or before the time when half of the crop is ripe, as then the early plants can be seen easily. When the crop is fully ripe the early plants can not be distinguished from the late ones. Earliness often is the deciding factor between success and failure of the crop in much of the grain-sorghum belt and should not be overlooked or neglected in making the selections.

Seed heads may be selected before they are ripe enough to harvest. In that case it is necessary to mark them in some way, so they can be found when harvest time comes. A tag or piece of binder twine tied to the base of the head makes a good marker. The twine alone is effective and inexpensive. Marking is not necessary if selection is delayed until the seed is ripe enough to harvest. Then the heads should be cut as they are selected. About 4 inches of stem should be cut off with the head. A burlap bag hung from the shoulder by a strap is the simplest container in which to place the heads as they are gathered.

STORING THE SEED HEADS.

Proper care of the seed heads after harvest is important in maintaining the vitality of the seed. The heads must be stored in a dry well-ventilated place where they are protected from damage by rats, mice, and birds. They will heat if piled before they are dry; hence they should be hung up as gathered. String them on baling wire or a cord and hang them from the ceiling or rafters of a granary or shed. The wire can be pushed through the stem and the ends twisted together after a number of heads have been put on. Cord can be substituted for the wire if a sacking needle is used to run it through the stems. About 50 heads make a bunch of convenient size to handle. Heads stored for the winter are shown in figure 10. The danger of injury by rats and mice is lessened if the bunches are suspended from the ceiling rather than hung against the walls of the building. If birds can get into the building the bunches of heads should be protected with old bags or papers.

PREPARING THE SEED FOR SOWING.

The seed heads should be carefully thrashed and the seed thoroughly cleaned and tested for germination. Seed of all varieties

except the milos and feterita should be treated for smut before it is sown. The milos and feterita so far have proved immune from attack by smut.

THRASHING THE SEED HEADS.

The seed heads may be thrashed either by hand or by machine in late winter or in early spring before the rush of spring work begins. The quantity of seed each farmer will need is in most cases so small that the use of a thrashing machine is not desirable.

A good way of thrashing by hand is to put the heads into a stout bag, tie the mouth, lay the bag on the floor or bench, and beat it

with a stick. The bag should not be filled too full and it should be turned over occasionally, so that all the heads will be beaten. For the best results, not more than about 50 heads should be put into a 2-bushel bag at one time. Where large numbers of heads are to be thrashed, more rapid progress can be made by using a large tarpaulin instead of a bag. This can be laid on the floor and the heads piled on until just room enough is left to bring the four corners



FIG. 10.—Seed heads of grain sorghums tied in bunches and stored for the winter.

of the tarpaulin together and tie them securely. Then a flail instead of a stick can be used to beat out the seed. Care must be taken to prevent cracking the seeds. The percentage of cracked seeds usually is much smaller when thrashing is done by hand than where a machine is used.

All the chaff, sticks, dirt, and cracked and immature kernels should be screened or blown out by a fanning mill. If no fanning mill is convenient, winnow the seed in the wind.

Hulls and cracked or immature kernels mixed with the good seed make uniform stands impossible.

SEED TREATMENT FOR KERNEL SMUT.

The smut treatment is as follows:¹

Mix 1 pound of commercial formaldehyde with 30 gallons of water. Put the seed in sacks and immerse the sacks in this solution for 1 hour, stirring it occasionally. Then take the sacks out and set them to drain. Spread the seed out on a clean floor or canvas. Be sure that all of the sacks, the barn floor, and the canvas used in handling the grain after treatment are cleaned either with boiling water or with a strong formaldehyde solution. The seed will be infected again if any untreated smut spores touch it. When the seed is sufficiently dry after treatment, it may be sown.

The same solution may also be used as a spray, in which case the seed to be treated should be spread out on a clean floor or canvas and sprinkled with the solution. It must be shoveled over frequently until all of the seeds are wet. It may then be shoveled into a pile, covered with a clean canvas or sacking to keep in the fumes, and left over night. In the morning it should be spread out to dry. Seed treated in this way will be free from smut. The immersion method is more thorough, but it is not as convenient as the sprinkling method.

GROWING THE CROP.

Grain sorghums will grow on almost any soil, ranging in type from light sandy soils to heavy clay loams. A maximum yield of 88 bushels to the acre has been produced on the sandy soil at the Big Springs Field Station, Big Springs, Tex. Similar yields have been recorded at the Amarillo Cereal Field Station, Amarillo, Tex., where the soil is a heavy chocolate loam.

Rich soils will produce higher yields than poor soils, other things being equal. However, most of the soils in the region where grain sorghums are important are productive enough to give good yields. Moisture and its distribution are more often the determining factors in sorghum production than the soil. With good seed, proper cultivation, and moisture sufficient for normal plant growth, good yields may be obtained on either light or heavy soils.

PREPARING THE SEED BED.

The work necessary to prepare a good seed bed depends largely upon the kind and condition of the soil. Light soils usually require less work than heavy soils. The seed bed should be uniform. All the large clods must be pulverized and the surface soil well worked, so that no large holes or air pockets are left, but the surface should not be worked into a fine dust mulch. Heavy soils puddle and bake after rains and light soils blow more readily if the surface is too fine.

¹ Freeman, Edward M., and Umberger, Harry J. C. *The smuts of sorghums*. U. S. Dept. of Agr., Bureau of Plant Industry Cir. 8, p. 6-7. 1908.

PLOWING.

Fall plowing gives better results on the average than spring plowing. Their relative values depend largely on the amount of moisture in the soil and on the winter precipitation. If plowing is done early in the fall, before the weeds have used the available moisture in the soil, and the winter precipitation is normal or above, then fall plowing has a decided advantage over spring plowing. Plowing destroys the weeds and helps to conserve the moisture already in the soil, while plowed land left rough over winter will catch the snow and hold more moisture than unplowed land. For the best results fall plowing on old land should be at a depth of 6 to 7 inches. Late in the spring shallow plowing is sometimes best if moisture in the surface soil is lacking and the crop is to be sown immediately after plowing is done. The seed may then be sown in contact with moist soil without being covered too deeply.

The first breaking of sod should be at a depth of about 3 inches.

HARROWING.

Harrowing puts the plowed land in condition for sowing the crop. How much is necessary to make a good, rather compact seed bed depends on the condition of the soil. When plowing is left rough over winter, usually one disking early in the spring and once over with a spike-tooth harrow just before the crop is sown are sufficient. The disk will pulverize the large clods, destroy weeds, and compact the soil, and the harrow will smooth the surface and destroy the small weeds which start after the land is disked. More work is necessary under unfavorable conditions, but the surface should not be worked into a fine dust.

LISTING.

Listing may take the place of plowing and is preferred by some farmers because it is a more rapid method of preparing the land. Listing prevents soil blowing to a greater extent than plowing and should be practiced on soils which blow. When listing is done in the early fall late weeds will be killed. The lister furrows will help prevent soil blowing and will catch the snow during the winter, thus saving moisture that otherwise often is lost. Because of the rapidity with which land can be prepared by listing and the benefits in saving moisture and preventing soil blowing, the practice is very general throughout the grain-sorghum area.

When listing is done in the fall or winter the best seed bed can be prepared by cutting down the ridges with a disk harrow in the spring and relisting the land at seeding time. The disking may be omitted and the ridges or middles split with the lister. This method gives good results under favorable conditions and avoids the expense of disking the land.

SOWING THE CROP.**HOW TO SOW.**

The grain sorghums are either surface grown or listed (figs. 11 and 12) in rows spaced about $3\frac{1}{2}$ feet apart. A corn drill (corn planter) or lister drill fitted with sorghum plates is used for sowing the crop. A better stand usually is obtained from surface sowing than from listing. The plants also grow better in the early part of the season, because the seed is placed near the surface where the soil is warmer and more favorable to germination and growth than it is at the bottom of the lister furrow. Under certain conditions the listed crop has advantages over the one which is surface sown. Listing helps to prevent soil blowing and the deep furrows protect the young plants from being whipped by the winds or cut to pieces by



FIG. 11.—A 2-row surface drill in operation at Amarillo, Tex.

moving particles of soil. The method to be used in any given locality depends largely on the soil type and on the weather conditions. Listing is very generally practiced in the drier portions of Kansas, Oklahoma, and Texas.

WHEN TO SOW.

The grain sorghums are of subtropical origin and therefore grow best where the temperatures are high. The seeds will not germinate well nor will the plants make normal growth in cold soils. For the best results seeding must not be done too early in the spring. A good time to sow in any given locality is from 10 days to 2 weeks later than the average date for planting corn there.

The best time to sow the sorghums in the Panhandle of Texas and adjacent territory is from about May 15 to June 10. If sowing is delayed much later the cool nights in September retard ripening and early frosts may catch the crop before it matures. South of the

Panhandle section sowing should start earlier. In the San Antonio (Tex.) section the crop should be sown early in March. This region has a long growing period, but the early-sown crop is most likely to escape damage from the sorghum midge, which usually does not appear in large numbers until June. By that time the early crop has passed the flowering stage, which is the period when the midge does its injury.

At Woodward, Okla., the time to sow the crop ranges from May 1 to June 15. In seasons that open early, so the soil is warm by May 1, early sowing gives the best results. In other seasons with late, wet springs, later sowing is desirable.



FIG. 12.—A 2-row lister-drill in operation at Hays, Kans.

HOW MUCH SEED TO SOW.

No one stand or rate will produce the highest yield under all seasonal conditions. Thick stands yield higher than thin ones in favorable seasons, but in dry seasons thin stands are best. The best average yield from Dwarf milo in the 5-year period from 1914 to 1918, inclusive, at the Amarillo Cereal Field Station, Amarillo, Tex., resulted from a stand of one plant to every 10 to 12 inches of row space in rows $3\frac{1}{2}$ feet apart. Dawn kafir yielded best from a stand of one plant to 14 to 16 inches of row space during the same period. Similar results have been obtained at other stations.

To get the stand desired it is necessary to sow at a heavier rate because all the seed will not germinate under field conditions, though it may have shown 100 per cent germination in the laboratory or the home test. From 2 to 3 pounds of clean viable seed ordi-

narilly is sufficient to sow 1 acre when the rows are spaced $3\frac{1}{4}$ feet apart. Heavier seeding may be necessary to obtain a stand under unfavorable conditions.

CULTIVATING THE CROP.

Cultivation should be begun early and repeated frequently enough to destroy weeds and keep the surface soil loose. The sorghum plants grow slowly when young and are easily injured by weeds. If weeds are allowed to grow in large numbers serious damage to the crop is sure to result. As much or more water is required to produce a large weed than a sorghum plant. When the available moisture is limited, as it usually is in the grain-sorghum region, that used by weeds is at the expense of the sorghum crop. This results in reduced yields or even in a total failure.

The spike-tooth harrow is a satisfactory implement to use for the first and often for the second cultivation of surface-sown sorghum. If the surface soil crusts or bakes so that the emergence of the plants is made difficult or if the weed seeds on the surface are germinating rapidly, then the first harrowing should be given before the plants are up and the second one before they are large enough to be worked satisfactorily with the shovel cultivator. On soils free from weed seeds and under favorable conditions for the plants to emerge, the first harrowing may be delayed until after the crop is up and the second harrowing may be omitted. The harrow teeth must be slanted backward at an angle which will prevent them from pulling out the seeds or young plants. The field should then be cultivated often enough to destroy all weeds and to keep the surface soil in a loose, mellow condition, so that it will take up moisture readily. The loss of moisture by run-off and from weed growth after the plants are too large to be cultivated will then be reduced to the minimum.

The listed crop can be best cultivated with lister cultivators. Some of these cultivators are equipped with disks, some with shovels, and others with both disks and shovels. The disks and shovels are adjustable, so that the soil can be thrown either to or from the plants. At the first cultivation the soil is thrown from the small plants, in order to prevent covering them. Later, as the plants grow taller, the dirt gradually is thrown toward the plants, filling the furrows and leveling the ridges at the same time. After the ridges are leveled, the ordinary shovel cultivator must be used if further cultivation is necessary.

HARVESTING.

Three methods of harvesting the grain-sorghum crop are in common use. These are (1) heading by hand, (2) heading with a grain header, and (3) harvesting the whole plant with a row binder. By the first and second methods the stalks are left standing in the field,

where they may be used for pasture or turned under as manure. In the third method both stalks and heads are harvested and the whole crop may be fed or the grain thrashed later. A row binder at work is shown in figure 13.

CURING.

The heads usually contain too much moisture at harvest time to be thrashed or put immediately into large bulk without danger of heating. In good weather the heads may be spread in a thin layer on grass and left to cure, which will take about 10 days. Then the heads may be thrashed, or they can be put into large piles or stacks and thrashed later. These stacks should be covered with some material



FIG. 13.—A row binder at work harvesting Sunrise kafir at Amarillo, Tex.

which will turn water and so protect the heads from heavy rains. A better and safer way to handle the heads, however, and one which requires but little added expense, is to provide well-ventilated bins or cribs where they can be stored as harvested. This saves one handling and prevents rain injury. The cribs should be not more than 6 feet wide, about 8 or 10 feet high, and as long as is necessary to hold the crop.

A simple method of constructing a crib is to set posts 6 feet apart in two parallel rows also 6 feet apart. A 2 by 4 scantling or a 6-inch board should then be spiked on the outside at the top of the posts. This will help to hold the posts in place and will support the roof. At least two pieces of the same material should be spiked to each pair of posts crosswise of the crib. One should be placed about 2

feet above the ground and another about 3 feet below the top of the posts. After the crib is filled and the mass of heads has settled, a small space will be left under each cross brace, which will permit free circulation of air through the crib. Thus, the braces not only hold the crib together but aid in the ventilation. The sides of the crib should be left as open as practicable. Woven-wire fencing makes satisfactory siding for this purpose. It should be stretched tightly on the outside of the posts and stapled securely to them. The mesh in the fencing must be small enough to keep the heads from falling through. Any heavy fencing with a small mesh will do. The roof may be made of any convenient material that will turn water.

The crop harvested with a row binder is cured best by setting the bundles in shocks in the field, where they may stand until dry. The shocks may contain from 12 to 18 bundles with safety, depending on the condition of the crop and the weather at harvest time. A well-matured crop can be put into larger shocks than one not so mature without danger of damage from heating or molding. The bundles should be set close together and all leaning slightly to the center. The finished shock will then shed most of the water from heavy rains.

THRASHING.

The grain sorghums are thrashed with the same machine that is used for thrashing the small grains. By adjusting the cylinder and concaves and regulating the speed to suit the nature of the crop, satisfactory results may be obtained. About half of the concave teeth should be removed and the speed of the cylinder reduced to about two-thirds that required for thrashing wheat. A large part of the seeds will be cracked if these adjustments are not made. The kernels are larger and softer than those of wheat and will not stand as hard thrashing.

If the crop was cured in the bundles it may be thrashed (1) by first cutting the head from the bundles with an ax or large knife and thrashing only the heads, (2) by holding the bundles against the cylinder until the heads are thrashed, and (3) by putting the whole bundles through the machine. The latter is possible only when the stalks are short and small. A thrashing crew at work is shown in figure 14.

STORING THE GRAIN.

The grain may be stored either in bins or bags. It should be free from foreign material and cracked kernels and should be dry when stored in large bulk or it will heat and spoil. Dirt, chaff, or cracked seeds will fill the spaces between whole kernels and keep out the air. In warm weather the grain will heat in a short time if it contains a high percentage of moisture. The grain should be watched while in

storage, and if heating starts it should be stirred so the air can pass through and cool it off. This is done at grain elevators by running the grain from one bin to another. More time and labor are required on the farm where the bins are not equipped with elevators. A safe way there is to equip the bins with ventilators or to store the grain in bags. The bags can be put in a dry place where the air will have free circulation around them. Grain entirely too moist to store in bins may be stored in this way with safety, and it will dry while in storage.

A simple ventilator for use in farm bins was devised by Mr. George Bishop and described by him in an issue of the *Oklahoma Farm Journal* during the autumn of 1915. The following description is adapted from that source:



FIG. 14.—Thrashing Dawn kafir which was harvested with a grain header, at Hays, Kans.

This ventilator (fig. 15) is a long, narrow box of wood and wire screen, extending from side to side of the bin and opening to the outer air. To make it, take two pieces of 1-inch board (*a*) 4 inches wide and as long as the bin is wide. Place these on edge about 4 inches apart. Take cleats or strips of wood (*b*) 1 inch thick and $1\frac{1}{2}$ or 2 inches wide, and mortise them into the upper edges of the boards (*a*), flush with the surface and about 1 foot apart.

Take galvanized-wire screen, either ordinary fly screen or similar screen with a mesh too small to permit kafir seeds to pass through. Cover the ends of the ventilator with pieces of screen (*c*) cut large enough to lap over on to the sides for an inch or so and tack tightly. Then cut the screen into strips wide enough (about 19 or 20 inches) to go completely around the ventilator box. Fasten all the screen (*d*) tightly with tacks or small staples.

The ventilator now has two wooden sides and a wire-screen top, bottom, and ends. Across the bottom nail several cleats (*c*) or strips of 1-inch lumber. These will lift the ventilator an inch from the floor and permit air to circulate freely in the lowermost layer of grain.

The ventilators should be placed 3 or 4 feet apart on the floor of the bin. The ends must fit into or set flush against holes cut in the outer walls of the bins. The wire screen over the ends of the ventilators prevents the entrance of rats or mice. Cold air circulating through

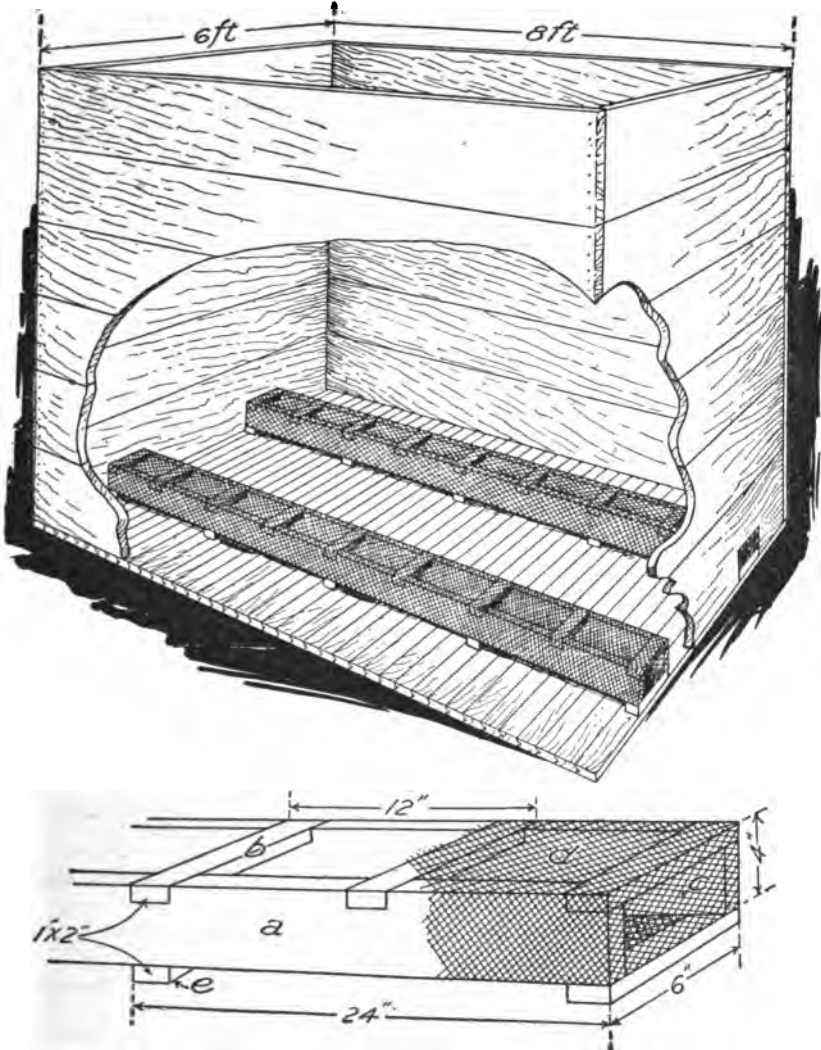


FIG. 15.—Ventilator for a bin containing sorghum grain. Upper figure, view of two ventilators in position on floor of bin, showing opening in side of bin. Lower figure, detailed structure and dimensions: *a*, side of ventilator; *b*, cleat mortised in upper edge of *a*; *c*, wire screen over end of ventilator; *d*, wire screen covering top and bottom, also sides; *e*, cleat on bottom to raise ventilator from floor.

the ventilator passes up through the grain and cools it if heating starts. In deep bins a row of ventilators placed upright through the center may be desirable. These should be placed with the lower end resting on the horizontal ventilator, thus giving a free circulation of

cold air through the mass of grain. When the bin is not in use for storing sorghum grain the ventilators may be removed and the bin used for other purposes.

PUBLICATIONS ON GRAIN SORGHUMS.

In the list that follows, those publications to which no price is attached may be obtained without charge upon application to the Secretary of Agriculture; publications in connection with which a price is mentioned may be obtained by remitting the stated sum to the Superintendent of Documents, Government Printing Office, Washington, D. C.

FARMERS' BULLETINS.

Better Grain-Sorghum Crops. *Farmers' Bulletin 448.* Price, 5 cents.
Kafir as a Grain Crop. *Farmers' Bulletin 552.* Price, 5 cents.
Use of Corn, Kafir, and Cowpeas in the Home. *Farmers' Bulletin 559.*
The Feeding of Grain Sorghums to Live Stock. *Farmers' Bulletin 724.*
Cereal Crops in the Panhandle of Texas. *Farmers' Bulletin 738.*
Shallu, or "Egyptian Wheat," a Late-Maturing Variety of Sorghum. *Farmers' Bulletin 827.*
Growing Grain Sorghums in the San Antonio District of Texas. *Farmers' Bulletin 965.*
How to Use Sorghum Grain. *Farmers' Bulletin 972.*
Milo, a Valuable Grain Crop. *Farmers' Bulletin 1147.*

DEPARTMENT BULLETINS.

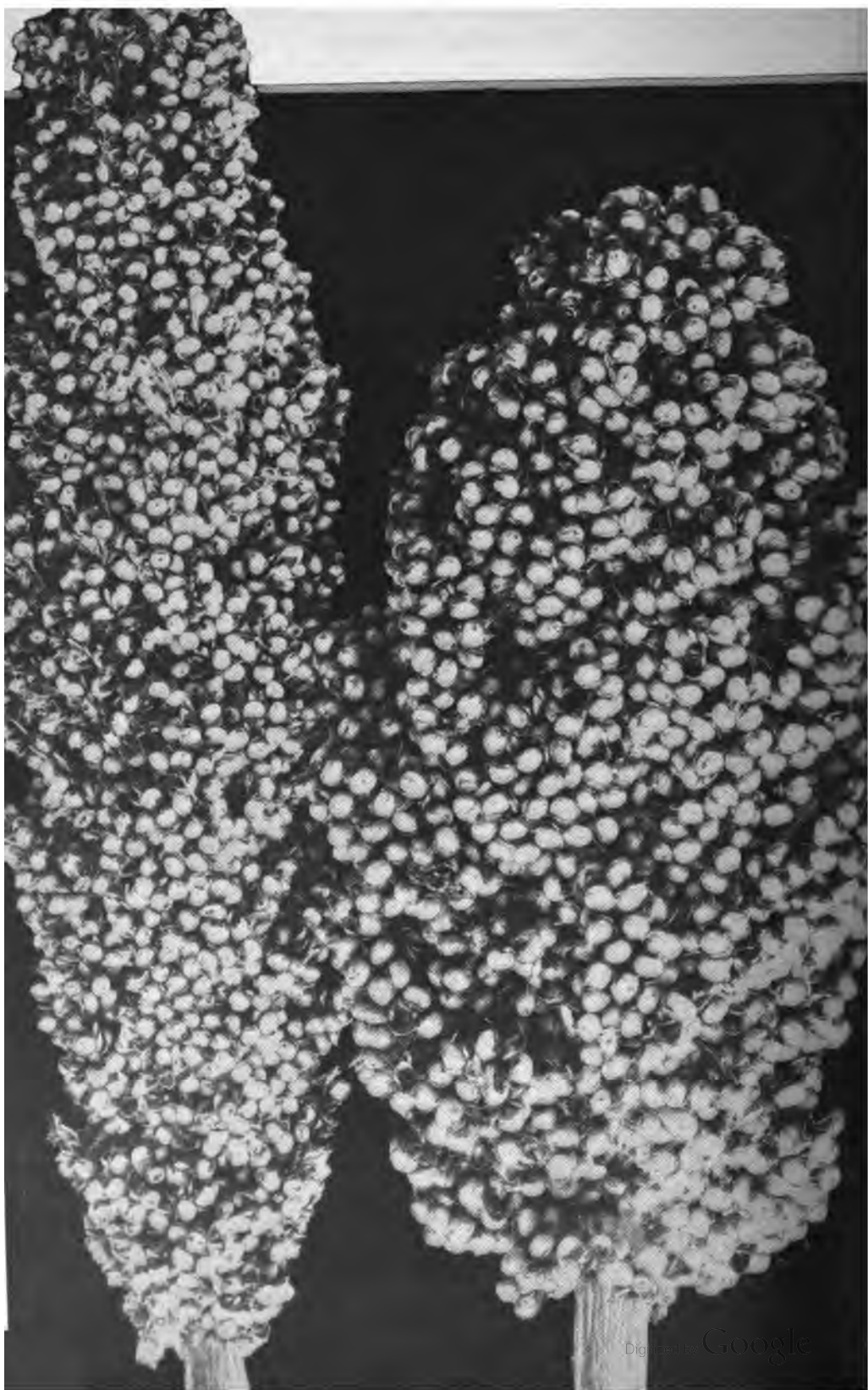
Corn, Milo, and Kafir in the Southern Great Plains Area: Relation of Cultural Methods to Production. *Department Bulletin 242.* Price, 5 cents.
Studies on the Digestibility of the Grain Sorghums. *Department Bulletin 470.*
Grain-Sorghum Experiments in the Panhandle of Texas. *Department Bulletin 698.*

BUREAU OF PLANT INDUSTRY BULLETINS.

The History and Distribution of Sorghum. *Bureau of Plant Industry Bulletin 175.* Price, 10 cents.
The Importance and Improvement of the Grain Sorghums. *Bureau of Plant Industry Bulletin 203.* Price, 10 cents.
Grain-Sorghum Production in the San Antonio Region of Texas. *Bureau of Plant Industry Bulletin 237.* Price, 5 cents.
The Kaoliangs: A New Group of Grain Sorghums. *Bureau of Plant Industry Bulletin 253.* Price, 15 cents.

BUREAU OF PLANT INDUSTRY CIRCULARS.

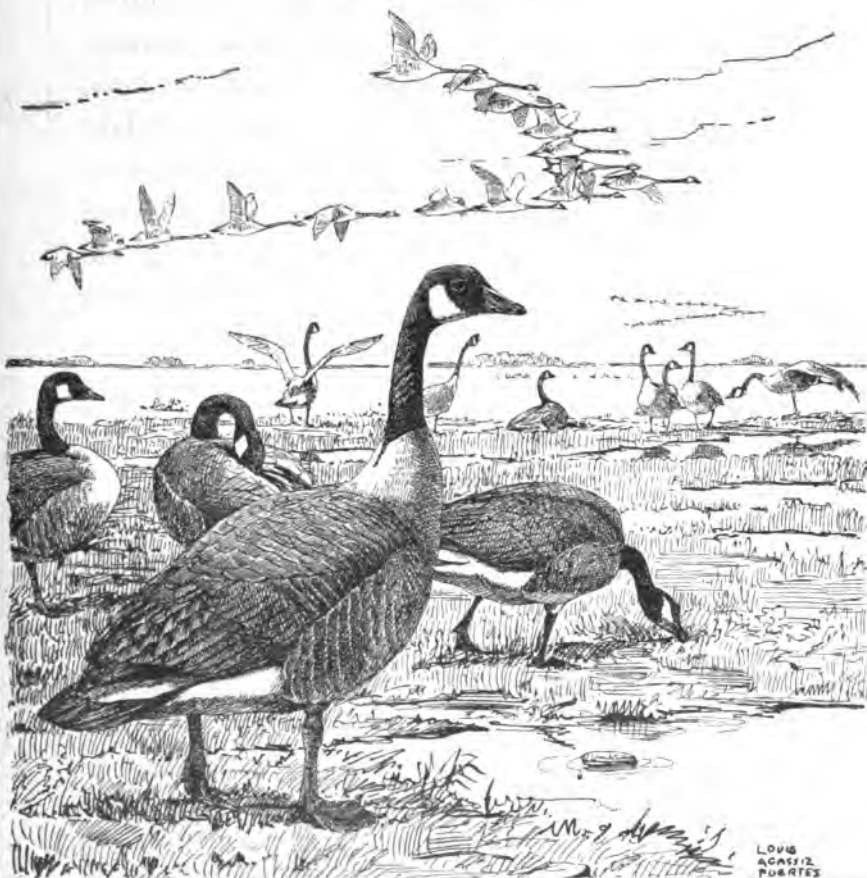
Three Much-Misrepresented Sorghums. *Bureau of Plant Industry Circular 50.* Price, 5 cents.
Feterita, A New Variety of Sorghum. *Bureau of Plant Industry Circular 122.* Price, 5 cents.



GAME LAWS

for 1920

*A Summary of the Provisions
of Federal, State, and Provincial
Statutes*



THE objects of this bulletin, containing the twenty-first annual summary of Federal and other game laws and regulations, are to present the provisions of game legislation in convenient form for sportsmen and others and to show its general condition and trend from year to year.

Provisions relating to methods of capture, game refuges, enforcement of laws, disposition of fees and fines, and matters of minor importance are omitted. These may be found by reference to the laws themselves or to pamphlet editions of the game laws, obtainable in most of the States from proper officials.

Provisions relating to seasons, licenses, limits, possession, sale, and export, and a few miscellaneous matters here presented, are grouped under State and other governments, alphabetically arranged, thereby furnishing the reader a brief and convenient synopsis of the laws.

Show this bulletin to a neighbor. Additional copies may be obtained free from the Division of Publications, United States Department of Agriculture.

Contribution from the Bureau of Biological Survey.

E. W. NELSON, Chief.

Washington, D. C.

August, 1920.

GAME LAWS FOR 1920.

A SUMMARY OF FEDERAL, STATE, AND PROVINCIAL STATUTES.

GEO. A. LAWYER, *Chief United States Game Warden*, and FRANK L. EARNshaw, *Assistant, Interstate Commerce in Game.*

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REVIEW OF LEGISLATION OF 1920.

The total number of game laws enacted in 1920 probably will not exceed 60, which is about normal for "even" years, when only a few States hold legislative sessions—regular sessions were held this year in 11 States¹ and in all the Provinces of Canada. Of the numerous specially called sessions, that of Ohio apparently was the only one in which any law relating to game was enacted. Further progress was made along the line of harmonizing State legislation with the migratory-bird treaty act regulations. New Jersey adopted a comprehensive act conforming her laws to the regulations in all particulars relative to taking migratory game birds for sport. Ken-

¹ Georgia, Kentucky, Louisiana, Maryland, Massachusetts, Mississippi, New Jersey, New York, Rhode Island, South Carolina, and Virginia. In Mississippi and Rhode Island no game legislation was enacted; and in Georgia the legislature convened too late for comment.

tucky adopted provisions in substantial conformity with the Federal regulations relative to seasons on ducks, geese, and Wilson snipe; to bag limits on wildfowl, Wilson snipe, woodcock, rails, coots, and gallinules; to hunting from an airplane, powerboat, or sailboat; to the use of guns larger than No. 10 gauge; and to hunting at night from sunset to half an hour before sunrise.

In Canada regulations were promulgated, under the amendment of 1919, to the migratory-birds convention act, prescribing daily bag limits; limiting the number of waterfowl that may be taken in a season in Alberta, British Columbia, Manitoba, Ontario, and Saskatchewan; prohibiting the use of certain kinds of guns, airplanes, powerboats, sailboats, or vehicles in hunting; prohibiting shooting from sunset to sunrise; prohibiting sale of migratory game birds in British Columbia, Manitoba, New Brunswick, Ontario, and Saskatchewan; and prescribing detailed regulations governing the propagation of migratory birds.

BIG GAME.

The most important changes affecting big game were in New York and Quebec. New York reenacted the buck law and limited a hunter to one buck a season. Under the law of 1919 one deer of either sex was allowed to be killed. The Conservation Commission of New York estimates that in 1919 more than 20,000 deer were killed, considerably more than half of which were does, and after careful investigation finds that 9 persons, mistaken for deer, were killed and 7 more or less seriously injured. The deer season was modified in several localities: In the Adirondacks it was shortened by opening October 15 instead of on the first of the month; in Orange, Rensselaer, and Sullivan Counties it was made county-wide; in Delaware County it was opened; and in Columbia County it was closed. In Quebec the season was shortened 19 days on deer and bull moose, except in four counties, and 50 days on caribou. The open season was limited to the period from September 20 to December 31, except in Pontiac and Temiscaming Counties, where the season on deer and bull moose was open 10 days earlier.

In South Carolina does were protected for a period of five years. In this connection it is interesting to recall that the former doe law, enacted in 1910, was repealed in 1911.

New Jersey lengthened the deer season five days by making the last day Christmas instead of December 20, but modified the provision allowing deer to be killed under permit to protect crops, by permitting landowners, lessees, and their authorized agents to kill deer at any time on their lands seeded to cultivated grasses or on which planted crops are growing.

Nova Scotia shortened the season two weeks on moose, while Ontario lengthened the season on deer six weeks in that part of the Province lying north of the Canadian Government Railway.

In Canada, provision was made for leasing South Baffin Land for use in the propagation of reindeer and musk-oxen.

GAME BIRDS.

Legislation of far-reaching importance looking to the preservation of quail and other upland game birds included an act of Congress, approved December 18, 1919, prohibiting the sale of upland game birds in the District of Columbia; and an act in Maryland prohibiting the sale of quail, ruffed grouse, introduced pheasant, and wild turkey in the State. The ready market existing for a number of years in the District of Columbia during a long open season for the sale of quail has been an incentive for the destruction of these birds and for illegal traffic in them in near-by States, a condition which the limited warden service was unable to suppress. The elimination of the commercial aspect should result during the next few years in a material improvement in quail-shooting conditions in Maryland, Virginia, and North Carolina. A further decided step in advance in game protection was the repeal of all local seasons in Maryland on upland game and the enactment of a uniform State season extending from November 10 to January 1.

The season on ruffed grouse in New York was shortened one month and the bag limits reduced from 4 to 2 a day and from 20 to 10 a season. In South Carolina the quail season was extended slightly by making the dates November 25 to March 1 instead of November 15 to February 15, and the season on wild turkeys was shortened six weeks and made uniform with that for quail. In Kentucky the close term on wild turkey, imported pheasant, and Hungarian partridge was continued until 1924, but under State law and Federal regulations woodcock may be taken only during the last half of November. In New York protection of quail throughout the State, except Long Island, was continued until 1925. Virginia prescribed State-wide daily bag limits on quail, ruffed grouse, and wild turkeys.

After protecting prairie chicken, partridge, and ruffed grouse since 1917, Manitoba provided a week's open season from October 15 to 22 and permitted the possession of the birds 10 days after the close of the season; provision was also made allowing ducks legally killed to be possessed during the first four months of the close season. Alberta fixed the period from October 15 to 31 as the open season on grouse, partridge, prairie chicken, and ptarmigan, thus shortening the season one month; Nova Scotia continued the close term on ruffed grouse (birch partridge) until 1922; and Saskatchewan

opened the season during the last half of October on prairie chicken and prescribed bag limits of 6 a day and 30 a season.

Local provisions of interest are acts in Maryland limiting the shooting of ducks on Wicomico River and its tributaries in St. Marys County to Tuesdays, Thursdays, and Saturdays of each week during the open season; and prescribing license requirements and restrictions relative to the placing of blinds on the Patuxent River and tributaries except in St. Marys County, the Potomac River in Charles and Prince Georges Counties, the waters of Talbot County, and the Wicomico and tributaries in St. Marys County. In New York the use of any floating device, except sailboats or power boats, was permitted in Reeves and Flanders Bays, at the west end of Great Peconic Bay, Long Island, and the use of floating devices other than sailboats, power boats, or batteries on the Hudson River and on lakes, ponds, streams, or parts thereof in counties bordering on the Hudson or through which it passes.

ADMINISTRATION.

In South Carolina the chief game warden will in future be elected by the general assembly and commissioned by the governor. The provision authorizing the State Audubon Society to recommend to the governor names of persons suitable for positions of chief game warden and fish and game wardens was repealed.

South Carolina provided that a definite portion (eleven-twentieths) of the receipts from the sale of hunting licenses shall constitute the game protection fund, the balance to be paid into the county school fund. Formerly such fees less expenses of enforcing the game laws in the county were returned to the county school fund.

Several changes in the legislation of Maryland should greatly increase the efficiency of the warden service. The salary of the State game warden was increased from \$1,800 to \$2,500 per annum, and the provision limiting his expenses to \$500 was repealed; appointment of deputies with police power throughout the State or such counties or cities as the conservation commission may designate was provided in lieu of county and local wardens. The restriction requiring the conservation commission to distribute the game protection fund in proportion to the amounts contributed by the respective counties was removed.

Massachusetts authorized the retirement of fish and game wardens disabled in line of duty.

New York repealed the provision requiring the chief game protector to furnish bond in the sum of \$1,000, but required a bond in the same amount of the deputy chief protector and of each inspector and provided that civil-service examinations for protectors of all grades shall be confined to counties.

GAME REFUGES AND PRESERVES.

Progress in the establishment of preserves or refuges is noted in the order in council, Northwest Territories, designed to preserve hunting grounds in the far north for the native Eskimos, by prohibiting hunting and trapping on Banks Island in the Arctic Ocean; and in a provision of an act extending the protected area in Victoria Harbor, British Columbia, to include Selkirk Waters, Victoria Arm, and Portage Inlet. British Columbia also made provision for the establishment of game preserves on water areas and on marsh and other lands, in addition to Crown lands, and prohibited hunting or the carrying of firearms on game preserves. Maryland prohibited trespassing on lands owned or controlled by the State for game preserves or refuges.

MISCELLANEOUS PROVISIONS.

In New Jersey it was made unlawful to remove the skin or feathers, mutilate the body, or to destroy the identity of sex of a game bird or animal in the field for the purpose of concealing its identity. Maryland removed protection from turkey buzzards, and British Columbia repealed the provision allowing the lieutenant governor in council to declare an open season on western and American robins and thrushes. New York made it unlawful to post lands unless the ownership or the right to control them is evidenced by an instrument in writing at the time of such posting. South Carolina now authorizes the chief game warden, instead of the secretary of state, to issue permits to collect birds for scientific purposes. Manitoba requires the holder of a resident bird license to return his license on or before December 15 to the chief game guardian with a sworn statement that he has not violated the game laws; for failure to make such return, in addition to a maximum fine of \$100, he may be refused a similar license in any subsequent year.

In connection with the enforcement of the dog law of Virginia, 15 per cent of the receipts from the sale of dog licenses was set aside as a fund to cover the expenses of the department of game and inland fisheries, including a salary allowance of \$900 to the commissioner of the department. The expenses of enforcing the dog law, which was enacted in 1918, were heretofore paid from the State game-protection fund. The commissioner reports that, as a result of the killing of stray and worthless dogs and the greater control of others, farmers of the State are already taking up the sheep-growing industry.

SUMMARY OF LAWS RELATING TO SEASONS, LICENSES, LIMITS, SALE, AND EXPORT.

The dates of open seasons for migratory game birds shown under the various States and Provinces are the times when these birds may be hunted without violating either State laws or Federal regulations.² Federal regulations now prohibit shooting from sunset to half an hour before sunrise.

The regulations under the Federal migratory-bird treaty act prohibit throughout the United States the killing at any time of the following birds:

Band-tailed pigeon; little brown, sand-hill, and whooping cranes; wood duck, eider ducks, swans; curlews, willet, upland plover, and all shorebirds (except the black-bellied and golden plovers, Wilson snipe or jacksnipe, woodcock, and the greater and lesser yellowlegs); cuckoos; flickers and other woodpeckers; nighthawks or bull-bats and whip-poor-wills; swifts; hummingbirds; flycatchers; bobolinks,³ meadowlarks, and orioles; grosbeaks; tanagers; martins and other swallows; waxwings; shrikes; vireos; warblers; pipits; catbirds and brown thrashers; wrens; brown creepers; nuthatches; chickadees and titmice; kinglets and gnatcatchers; robins and other thrushes; and all other perching birds which feed entirely or chiefly on insects; and also auks, auklets, bitterns, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, and terns.

In some States certain days of the week constitute close seasons throughout the time in which killing is permitted. Hunting on Sunday is prohibited in all States and Provinces east of the one hundred and fifth meridian except Illinois, Louisiana, Michigan, Texas, Wisconsin, and Quebec. Mondays constitute a close season for waterfowl locally in Maryland and North Carolina; and certain other week days for waterfowl in several favorite ducking grounds in Maryland, Virginia, and North Carolina. Hunting is prohibited on election day in Maryland in Allegany, Baltimore, Cecil, Charles, Frederick, and Harford Counties; and when snow is on the ground in New Jersey, Delaware, Virginia, and Maryland.

The county laws of North Carolina, which are too numerous to be included satisfactorily, are not incorporated in the following summary, which otherwise may be regarded as a practically complete résumé of the regulations now in force.

The migratory-bird treaty-act regulations permit the possession of migratory game birds during the open season and the first 10 days

² The full text of the migratory-bird treaty, act, and regulations will be found on pages 64-75.

³ See order of the Secretary permitting bobolinks or reedbirds to be killed in a few States for the protection of rice crops in the South, p. 76.

following the close of the season. This provision has been considered in connection with State laws, and when migratory game birds may be legally possessed under Federal regulations and State laws during any part of the close season, it has been stated under the heading "Bag limits and possession." Possession of nonmigratory game during the close season is generally prohibited by State laws, but when an extension of a few days or a special season is provided for either possession or sale attention is called thereto.

Under the Federal migratory-bird treaty act the sale of all migratory game birds is prohibited throughout the United States (except birds taken for scientific or propagating purposes, and waterfowl raised on farms or preserves, under proper permit from the Secretary of Agriculture—see regulations 8 and 9, pages 73-74).

In stating the open seasons⁴ the plan of the New York law, to include *the first and the last days thereof*, has been followed. The difficulty of securing absolute accuracy in a statement of the seasons is very great, but the following summaries have been submitted to the proper State or Provincial game commissioners for approval, and are believed to be free from material errors. Seasons which apply only to special counties are placed to the left of the column containing those for the State in general. Species (including migratory game and nongame birds protected throughout each year by Federal regulation) on which the season is closed for a term of years or an indefinite period are grouped under the term "No open season." Provisions of State laws prohibiting hunting at night, between sunset and sunrise, or during certain hours, are not included.

Persons are advised to secure from State game commissioners⁵ the full text of game laws in States where hunting is contemplated.

State Laws.

ALABAMA.

Open seasons: ⁴	Dates inclusive.
Deer (male).....	Nov. 1-Jan. 1.
Squirrel (black, gray, fox).....	Nov. 1-Feb. 1. ⁷
Bear, quail (partridge).....	Nov. 1-Mar. 1.
Ruffed grouse (pheasant), introduced pheasant, or other introduced game bird.....	Nov. 15-Dec. 15.
Wild turkey gobbler.....	Dec. 1-Apr. 1.
Turtle dove.....	Oct. 16-Jan. 31.
Duck, goose, brant, black-bellied and golden plovers, Wilson snipe, yellowlegs, coot (mudhen), gallinule.....	Nov. 1-Jan. 31.
Woodcock.....	Nov. 1-Dec. 31.
Rail, other than coot and gallinule.....	Sept. 1-Nov. 30.

⁴ For open seasons on fur-bearing animals, see Farmers' Bulletin 1165, 1920.

⁵ See p. 83. A full list of names and addresses of officials and organizations concerned with the protection of birds and game will be found in Dept. Circ. 131, U. S. Dept. Agr., 1920.

⁶ *Alabama*: Hunting prohibited on all State lands.

⁷ Squirrels may be killed at any time on own premises when destroying property.

No open season: Does, elk (1925); hen turkeys, swans, wood duck, bitterns, sandhill and whooping cranes, grebes, gulls, herons, loons, shearwaters, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident or alien, \$15; Resident: State, \$3; county, \$1. Trapping (beats and other fur-bearing animals), \$10. Issued by probate judges. Landlords, tenants, and members of families may hunt or trap on own land during open season without license. Written permission required for hunting or trapping on land of another.

Bag limits and possession: One deer, 10 squirrels, 2 turkey gobblers, 25 of each other kind of upland game bird a day; 25 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 6 woodcock, 25 snipe, and 25 in all of other rails, coots, and gallinules, 25 doves a day. Possession of migratory birds permitted during first 10 days of close season; other game during first 5 days thereof.

Other: Sale of all protected game prohibited.

Export: Export of all protected game prohibited, except that a nonresident licensee may take with him, openly, game he has lawfully killed, but not more than 2 days' limit of migratory birds may be exported in any one calendar week.

Commissioner of conservation may issue a \$1 permit to any person to capture or transport not more than 10 pairs of any one species of game bird for scientific or propagating purposes.

ALASKA.

Open seasons:*

North of latitude 62°—

Dates inclusive.

Moose (females and yearlings protected all the year), caribou, sheep—Aug. 1–Dec. 10.

South of latitude 62°—

Deer with horns 3 inches long (Southeastern Alaska) (see exception)

Aug. 15–Oct. 31.

Exception: Deer on Duke, Gravina, Kodiak, Long, Krusof, San Juan, Suemez, Zarembo, Hawkins, Hinchinbrook, and Moutague Islands, 1921.

Mountain goat in Southeastern Alaska east of longitude 141° and on Kenai Peninsula—

Sept. 1–Oct. 31.

Moose (females and yearlings protected all the year), caribou, sheep (see exception)—

Aug. 20–Dec. 31.

Exception: Caribou on Kenai Peninsula; sheep, Kenai Peninsula, east of longitude 150°, July 15, 1921.

Brown bear—

Oct. 1–July 1.

Throughout Territory—

Grouse, ptarmigan—

Sept. 1–Mar. 1.

Duck, goose, brant, Wilson snipe, black-bellied and golden plovers, yellowlegs, coot, gallinule—

Sept. 1–Dec. 15.

No open season: Females and young of deer and mountain sheep, mountain goat kids, and fawns of caribou, south of Arctic Circle; swans, wood duck, elder ducks, aukslets, little brown crane, fulmars, grebes, guillemots, gulls, herons, jaegers, loons, murre, petrels, puffins, shearwaters, terns and all shorebirds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, \$50; nonresident alien, \$100. Guide, first-class, \$25 (American citizen); second class, \$7.50 (native of Alaska—fee fixed by governor).

Shipping licenses: Resident, \$40 (export of heads or trophies); \$10 (single trophy of caribou or sheep); \$5 (single trophy of deer, goat, or brown bear). Special license for shipping one moose killed south of latitude 62°, \$150.

(Not more than one general (\$40) license and two special (\$150) moose licenses issued to one person in one year. Each shipper must file with the customs office at port of shipment an affidavit that he has not violated the game law; that the trophy to be shipped has not been bought or purchased, has not been sold, and is not shipped for purpose of sale; that he is the owner of the trophy, and, in case of moose, whether the animal from which it was taken was killed north or south of latitude 62°.)

Bag limits and possession: Three deer, 2 moose, 3 caribou, 3 sheep, and 3 brown bears a season; 25 grouse or ptarmigan, 25 ducks, 8 geese, 8 brant a day, 25 in all in possession; 15 in all of plovers and yellowlegs, 25 Wilson snipe, 25 shorebirds in possession; 25 in all of coots and gallinules a day. Possession of migratory birds permitted during first 10 days of close season.

*Alaska: Game animals or birds may be killed at any time for food or clothing by native Indians or Eskimos, or by miners or explorers in need of food, but game so killed may not be shipped or sold.

Sale: Sale prohibited of heads, hides, and skins of all protected game; deer in Southeastern Alaska; moose, caribou, sheep, and goats south of Chugatch or Coast Range Mountains, including Kenia Peninsula and east to longitude 141°. Serving deer or caribou on vessels east of Unimak Pass also prohibited. Sale of migratory birds prohibited.

Permitted: Carcasses of all game (except migratory birds, and deer, moose, and sheep as above stated) may be sold during the open season and 15 days thereafter.

Export: Export prohibited of deer, moose, caribou, sheep, goat, bear, or hides of these animals; wild birds, except eagles, or any parts thereof: *Provided*, specimens may be exported under restrictions imposed by the Secretary of Agriculture, and trophies of big game under licenses issued by the governor. (See Licenses.)

ARIZONA.

Open season.⁹

Dates inclusive.

Deer (male), wild turkey	Oct. 1–Nov. 1.
Quail (except bobwhite)	Oct. 15–Dec. 31.
Mourning dove	Sept. 1–Dec. 15.
White-winged dove	July 15–Dec. 31.
Duck, goose, brant, Wilson snipe, coot, gallinule	Oct. 15–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Oct. 15–Dec. 15.
Rail, other than coot and gallinule	Oct. 15–Nov. 30.

No open season: Does, spotted fawns, elk, antelope, sheep, goat, bobwhite, grouse, pheasant, swans, bitterns, little brown and sandhill cranes, grebes, gulls, herons, loons, band-tailed pigeon, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident or alien: Game and fish, \$20; birds (except turkeys) and fish, \$10. Not issued to applicant under 12 years of age. Resident: Game and fish, \$1.25. Issued by game warden, designated deputies, and clerk, board of supervisors.

American-born resident under 17 years of age may hunt without a license, if accompanied by a holder of a general license.

Bag limits and possession: One deer, 2 turkeys a season; 20 ducks, 8 geese, 20 coots, 15 plovers and yellowlegs, and 20 rail, but not more than 20 in all of waterfowl, plovers, yellowlegs, rails, and coots a day or in possession; 25 quail, and 25 doves and white wings a day or in possession; 25 Wilson snipe a day. Possession of plovers, yellowlegs, rails, and mourning doves permitted during first 10 days of close season; other game during first five days thereof.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited, except for scientific or propagating purposes under permit from State warden.

ARKANSAS.

Open seasons:

Dates inclusive.

Deer (buck), bear	Nov. 10–Jan. 15.
Squirrel	May 15–Jan. 15.
Turkey gobblers	Nov. 10–Jan. 15. { Mar. 1–May 1.
Quail (partridge)	Nov. 20–Feb. 1.
Duck, goose, Wilson snipe, coot, gallinule	Nov. 1–Jan. 31.
Woodcock	Nov. 1–Dec. 31.
Black-bellied and golden plovers, yellowlegs, dove	Sept. 1–Dec. 15.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Does, fawns, wild turkey hens, pheasant, grouse, prairie chicken (1922); swans, wood duck, bitterns, sandhill and whooping cranes, grebes, gulls, herons, loons, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses:¹⁰ Nonresident for deer, bear, and turkey, \$15; resident, \$1.10. For dog in hunting, \$1.50. Issued by State game and fish commission and circuit clerks. No license required of citizen to hunt or fish during open season on own premises. Hunting prohibited on inclosed lands without consent of owner.

⁹ *Arizona:* Animals or birds (except migratory birds) which become seriously injurious to agriculture or other interests may be killed under regulations of the State game warden.

¹⁰ *Arkansas:* Fishing licenses to use artificial bait: Resident, \$1.10; nonresident, general, \$5; special 15-day (trip) license, \$1.10.

Bag limits and possession: Two deer, 1 bear, 4 turkeys a season; 15 squirrels, 20 quail (40 in possession); 25 doves, 25 ducks (50 in possession); 8 geese, 8 brant, 25 Wilson snipe, 6 woodcock, 15 in all of plovers and yellowlegs, 25 in all of rails, coots, and gallinules a day or in possession. Possession of game permitted during first 10 days of close season.

Sale: Sale prohibited of all protected game (except squirrels).

Export: Export of all game prohibited; provided, a nonresident, under his license and affidavit that game was legally taken by himself and is not for sale, may take with him one day's bag limit. Commission may permit game to be shipped from the State for propagation.

CALIFORNIA.¹¹

Open seasons:

Dates inclusive.

Male deer (except spike bucks), in districts 1, 1½, 4½, 23, 24, 25, and 26	Aug. 15-Oct. 14.
In districts 2 and 3	Aug. 1-Sept. 14.
In district 4	Aug. 15-Sept. 15.
Bear (black, brown)	Oct. 15-Mar. 1.
Tree squirrel	Sept. 1-Dec. 31.
Cottontail and brush rabbits, mountain, valley, and desert quail (see exceptions)	Nov. 15-Jan. 21.
<i>Exceptions:</i> Mountain, valley, and desert quail, districts 4 and 4½	Oct. 16-Dec. 31.
Mountain quail, districts 1, 23, 24, 25, and 26	Sept. 1-Nov. 30.
Grouse	Sept. 15-Oct. 14.
Sage hen (except in district 4, no open season)	Aug. 15-Sept. 30.
Dove	Sept. 1-Oct. 31.
Duck, goose, brant, Wilson snipe or jacksnipe, coot (mudhen), gallinule	Oct. 16-Jan. 31.
No open season: Doe, spike buck, fawn, elk, antelope, sheep, pheasant, introduced quail or partridge, turkey, rail, plover, yellowlegs, swans, wood duck, elder ducks, snaillets, bitterns, little brown and sandhill cranes, fulmars, grebes, gullmots, gulls, herons, jaegers, loons, murrens, petrels, band-tailed pigeons, puffins, shearwaters, terns, and all shore birds (except Wilson snipe or jacksnipe).	

¹¹ *California:* Of the 57 fish and game districts created under the act of 1917, as amended in 1919, 6 (1, 1½, 2, 3, 4, and 4½) are properly hunting districts; 23, 24, 25, and 26 are fishing districts, but are open to hunting; the other 47 are fishing districts or fish and game refuges.

District 1 comprises the northern part of the State, the Sierras, and the east half of the Sacramento and San Joaquin Valleys, including all counties not included in districts 1½, 2, 3, 4, and 4½.

District 1½ comprises the counties of Del Norte, Siskiyou, and Humboldt.

District 2 comprises that part of the State south of Humboldt and Tehama Counties, west of the Sacramento River and north of San Francisco Bay, including the counties of Mendocino, Glenn, Colusa, Yolo, Solano, Napa, Lake, Sonoma, and Marin.

District 3 comprises the region around the southern portion of San Francisco Bay and the coast counties south of the Golden Gate as far as Ventura, including the counties of Contra Costa, Alameda, Santa Clara, San Francisco, Santa Cruz, Monterey, San Luis Obispo, Santa Barbara, and Ventura; also San Benito and the west half of San Joaquin, Stanislaus, Merced, Fresno, and Kern Counties.

District 4 comprises the counties in southern California, namely, Los Angeles, Orange, Riverside, San Diego, Imperial, and San Bernardino.

District 4½ comprises the counties of Mono and Inyo.

Districts 23, 24, 25, and 26, all located in district No. 1, are as follows:

District 23 comprises the drainage area of Lake Tahoe and the Truckee River in the counties of Placer and Eldorado.

District 24 comprises the drainage area of Shiver, Twin, Blue, Meadow, and Wood Lakes in the counties of Alpine and Amador.

District 25 comprises the drainage area of Lake Almanor in the counties of Plumas and Lassen.

District 26 comprises Sixty Lake Basin, part of Rae Lake, and to the south fork of Woods Creek, in Fresno County.

Hunting licenses: ²² Nonresident, \$10; alien, \$25 (except those with first papers, fee \$10); resident, \$1; veterans of Civil War, free of charge. Issued by commissioners and county clerks. Unlawful to hunt in inclosure of another without permission of owner.

Bag limits and possession: Two deer, 12 tree squirrels a season; 15 cottontail or brush rabbits a day or 30 a week; 4 grouse a day or 8 a week; 4 sage hens a day or 8 a week; 10 mountain quail or day or 20 a week; 15 valley or desert quail a day or 30 a week; 25 Wilson snipe or jacksnipe a day or 50 a week; 15 mourning doves a day or 30 a week; 25 ducks and 8 geese a day or 50 a week combined; 25 coots (mudhens) and gallinules a day, 50 coots a week; 8 honkers or black sea brant a day or 24 a week.

Possession in excess of daily limit prohibited. Persons killing deer must retain in possession during open season and 10 days thereafter the skin and the portion of head bearing horns. One day's limit of game birds or animals may be possessed during first five days of close season.

Sale: Sale of deer meat and hides, tree squirrels, and all game birds prohibited.

Hides of deer lawfully killed when duly tagged under affidavit (fee 25 cents) may be sold August 1-December 31 (tags must be secured during open season or within five days thereafter). Cottontail and brush rabbits may be sold. Domesticated reindeer may be imported and sold under regulations of fish and game commission.

Export: Export of all protected game prohibited, except for scientific or propagating purposes under permit from board of fish and game commissioners. All shipment by parcel post prohibited.

COLORADO.

Open seasons:

Dates inclusive.

Deer (having horns with two or more prongs)-----Oct. 1-Oct. 4.

Rabbit, hare-----Unprotected.

Prairie chicken, mountain and willow grouse-----Sept. 15-Oct. 1.

Sage chicken-----Aug. 15-Sept. 1.

Dove (one day only)-----Sept. 1.

Duck, goose, brant, coot, gallinule, Wilson snipe or jacksnipe, black-bellied and golden plovers, yellowlegs-----Sept. 16-Dec. 31.

Rail, other than coot and gallinule-----Sept. 16-Nov. 30.

No open season: Elk, antelope, sheep, quail (bob-white crested), pheasant (1924); doe, partridge, ptarmigan, wild turkey, swans, wood duck, elder ducks, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, jaegers, loons, band-tailed pigeons, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: Big game, \$25; birds, \$5; fish, \$2. Resident: big game, \$2; small game and fish, \$1. No person under 18 permitted to hunt big game. Fishing license not required of boys under 16 or of women. Children under 12 not permitted to hunt except on own premises or those of parent or guardian. Guide, \$5. Issued by commissioner, county clerks, and other agents. Unlawful to hunt in any inclosure not public land without consent of owner. Unlawful to shoot game from public highway.

Unnaturalized foreign-born residents not permitted to hunt.

Bag limits and possession: One deer a season, coupon required; prairie chicken, sage hen, mountain and willow grouse, 10 in all a day, 15 in possession. Twenty-five doves, 20 ducks, 8 geese, 8 brant, 20 Wilson snipe, 20 in all of rails, coots, and gallinules, 15 in all of plovers and yellowlegs, but not more than 20 in all of migratory game birds a day, 35 in possession. Persons under 12 years of age limited to half this number of birds. Possession of rails permitted during first 10 days of close season; other game during first 5 days thereof. Commissioner may issue permit authorizing storage, possession, and use of upland game for 90 days after close of open season, and migratory birds for 10 days after close of season.

Sale: Sale of all game taken in State prohibited. Imported game (except migratory birds) may be sold under license by indorsement of shipping invoice to purchaser.

Export: The export of all protected game is prohibited; provided, birds, not exceeding the numbers allowed in possession, may be exported under permit from game commissioner (fee 25 cents for each bird) if permit be attached and packages plainly marked so as to show nature of contents, but not more than 2 days' limit of migratory birds shall be exported in any one calendar week; edible portion of deer may be exported under \$5 permit from commissioner.

²² *California:* Fishing licenses required of persons 18 years or age and over: Nonresident or alien, \$3; resident, \$1.

CONNECTICUT.

Open seasons:

Deer. ¹²	Dates inclusive.
Hare, rabbit (except Belgian or German hare, unprotected).....	Oct. 8-Dec. 14. ¹⁴
Gray squirrel, quail, ruffed grouse, pheasant (introduced), Hungarianian partridge, woodcock.....	Oct. 8-Nov. 23.
Duck, goose, brant.....	Oct. 1-Jan. 15.
Coot (mudhen), gallinule.....	Oct. 1-Dec. 31.
Black-bellied and golden plovers, yellowlegs.....	Sept. 1-Nov. 30.
Wilson or English snipe.....	Oct. 1-Nov. 30.
Rail, other than coot and gallinule.....	Sept. 12-Nov. 30.
No open season: Dove, swans, wood duck, elder ducks, auks, bitterns, fulmars, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murre, petrels, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).	
Hunting and fishing licenses: Nonresident: Game, \$10.25; fish, \$2.25. ¹⁵ Alien, \$15.25. Resident citizen, \$1.25. Not issued to persons under 16. Issued by city or borough clerk. No license required of resident and his children to hunt during open season on land on which he is actually domiciled if land is not used for club or shooting purposes.	

Bag limits and possession: Six gray squirrels a day, 30 a season; 3 rabbits a day, 30 a season; 5 each of quail and woodcock a day, 36 each a season; 3 ruffed grouse a day, 21 a season; 3 Hungarian partridges a day, 21 a season; 2 pheasants a day, 15 a season; 25 in all of ducks, geese, and brant, but not exceeding 8 geese and 8 brant a day; 10 in all of plover, yellowlegs, and Wilson snipe; 35 sora and 25 in all of other rails, coot, and gallinules a day, but not more than 35 in all of sora and other rails. Possession of rails permitted during first 10 days of close season.

Sale: Sale of squirrels, rabbits, and introduced pheasant permitted during open season. Sale of other game prohibited.

Export: Export of quail, ruffed grouse, and woodcock prohibited; provided, a nonresident licensee under permit may take out in his immediate possession game lawfully killed, when duly tagged, if not for sale; but not more than two days' limit of migratory birds shall be exported in any one calendar week.

DELAWARE.

Open seasons:¹⁶

	Dates inclusive.
Rabbit, hare, quail, partridge, woodcock.....	Nov. 15-Dec. 31.
Squirrel (fox, black, gray).....	Sept. 15-Nov. 1.
Dove (except in Newcastle County, no open season).....	Nov. 15-Dec. 15.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule.....	Oct. 16-Jan. 31.
Black-bellied and golden plovers, yellowlegs.....	Aug. 16-Nov. 30.
Rail, other than coot and gallinule.....	Sept. 1-Nov. 1.
Woodcock.....	Sept. 1-Oct. 30. ¹⁷

No open season: Hungarian partridge or pheasant, swans, wood duck, elder ducks, bitterns, sandhill crane, grebes, gulls, herons, loons, murre, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: Game, \$40.50; fish, \$3.50 (not good in Delaware River or Bay). Issued by commission. Unlawful to hunt on land of another without permission from owner or occupant. Fishing license not required of certain excursionists. Nonresidents who own or lease property at seaside summer resorts and their relatives, friends, and patrons sojourning at such resorts may fish for non-game fish and hunt without license during open season, between June 1 and September 30.

¹² *Connecticut:* Owner of agricultural lands, member of family, or employee may kill deer with a shotgun at any time on such lands when damaging fruit trees or growing crops, but such killing or wounding must be reported to the commissioners within 12 hours.

¹⁴ Between Nov. 24 and Dec. 15 hunting rabbits is permitted with dog and ferret only.

¹⁵ Required only of residents of States which require a nonresident to obtain an angling license. Not required of nonresident taxpayer or member of his family, nor of persons under 16 years of age.

¹⁶ *Delaware:* Minors under 15 years of age not permitted to hunt game with shotgun or rifle unless accompanied by an adult lawfully hunting.

¹⁷ See order of Secretary of Agriculture, p. 76.

Bag limits and possession: Six in all of rabbits, hares, and squirrels, 20 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 6 woodcock, 50 sora, 25 in all of other rails, coots, and gallinules, but not more than 50 in all of sora and other rails combined; 12 birds of any other species (except reedbirds) a day. Possession of migratory birds permitted during first 10 days of close season; other game during first 5 days thereof.

Sale: Sale of reedbirds and all protected game prohibited; provided, a resident may sell in his own county 20 rabbits a season, lawfully taken by him. Imported rabbits may be sold from November 15 to December 31.

Export: Export of rabbit, squirrel, quail, partridge, dove, woodcock, goose, and brant is prohibited; provided, holder of license may export, open to view, 10 rabbits, 10 squirrels, 50 rails, and 20 birds or fowl of any other species a week, lawfully killed by himself, under affidavit that the game is not for sale. Resident may export ducks, snipe, and plover. In no event, however, shall a person export more than 2 days' limit of migratory birds in any one calendar week. Under permit (fee, \$1) of board, 10 pairs of any one species of game or birds may be captured or transported.

DISTRICT OF COLUMBIA.¹⁸

Open seasons:

Dates inclusive.

Deer meat (sale or possession)-----	Sept. 1-Jan. 1.
Rabbit (except English rabbit, Belgian hare), squirrel-----	Nov. 1-Feb. 1.
Marsh blackbird-----	Sept. 1-Feb. 1.
Duck, goose, brant, Wilson snipe, coot, gallinule-----	Nov. 1-Jan. 31.
Black-bellied and golden plovers, yellowlegs, rail or ortolan-----	Sept. 1-Nov. 30.
Woodcock-----	Nov. 1-Dec. 31.
Reedbird-----	Sept. 1-Oct. 30. ¹⁹

No open season: Dove, swans, wood duck, bitterns, grebes, gulls, herons, loons, murre, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Bag limits and possession: Twenty-five ducks, 8 geese, 8 brant, 25 Wilson snipe, 6 woodcock, 50 sora, 25 in all of other rails, coots, and gallinules, 15 in all of plovers and yellowlegs a day. Possession of migratory birds permitted during first 10 days of close season; quail, November 1 to March 15; ruffed grouse or pheasant (except English or other imported pheasants raised in inclosures, possession unrestricted) and wild turkey, November 1 to December 26; prairie chicken (pinnated grouse), September 1 to March 15.

Sale: Sale of all game birds prohibited; provided, Hungarian partridge, English, ring-neck, Mongolian, or Chinese pheasants raised in captivity may be sold at any time. Deer, rabbit, and squirrel may be sold during open season.

Export: Export of migratory game birds in excess of two days' bag limit in any one calendar week prohibited.

FLORIDA.

Open seasons:

Dates inclusive.

Deer, squirrel (see exceptions), quail (bobwhite partridge), wild turkey-----	Nov. 20-Mar. 1.
<i>Exceptions:</i> Squirrels in Escambia County-----	Oct. 15-Mar. 1.
Squirrels in Holmes and Walton Counties-----	Oct. 20-Mar. 1.
Ruffed grouse, imported pheasants (see exception)-----	Nov. 20-Dec. 19.
<i>Exception:</i> English pheasant in Escambia County, no open season.	
Duck, goose, brant, black-bellied and golden plovers, Wilson snipe, yellowlegs, coot, gallinule, dove-----	Nov. 20-Jan. 31.
Woodcock-----	Nov. 1-Dec. 31.
Rail, other than coot and gallinule-----	Nov. 20-Nov. 30.
Reedbird (ricebird)-----	Aug. 16-Nov. 15. ²⁰

No open season: All wild birds and animals (except opossum and skunk) protected on Pine Island, Lee County. Swans, wood duck, bitterns, sandhill and whooping cranes, gannet, grebes, gulls, herons, jaegers, loons, petrels, shearwaters, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

¹⁸ *District of Columbia:* Hunting prohibited in the District by act of June 30, 1906, except on the marshes of the Eastern Branch above Anacostia Bridge and below the Aqueduct Bridge on the Virginia side of the Potomac, but in these areas no birds may be shot within 200 yards of any bridge or dwelling.

¹⁹ See order of Secretary of Agriculture, p. 76.

²⁰ *Florida:* See order of Secretary of Agriculture, p. 76.

Hunting license: Nonresident or alien (county license), \$15; resident, \$1 (county of residence); resident, \$3 (county other than county of residence). License not required in voting precinct nor of Confederate veteran entitled to a State pension. Issued by county judge.

Bag limits and possession: Three deer, 10 turkeys, and 300 of any other game birds a year; 1 deer, 2 turkeys, 20 quail, 25 ducks, 8 geese, 8 brant, 25 Wilson snipe, 6 woodcock, 25 in all of rails, coots, and gallinules, 15 in all of plovers and yellowlegs, and 25 doves a day. Possession of migratory birds permitted during first 10 days of close season; other game during first 5 days thereof.

Sale: The sale of redbirds (ricebirds) and all protected game is prohibited.

Export: Export of all protected game is prohibited, except nonresident licensee may carry out game as personal baggage, but not more than two days' limit of migratory game birds shall be exported in any one calendar week.

GEORGIA.

Open seasons:	Dates inclusive.
Deer	Oct. 1-Nov. 30.
Rabbit, fox squirrel	Unprotected.
Cat squirrel, opossum	Oct. 1-Feb. 28.
Quail, partridge, wild turkey gobblers	Nov. 20-Feb. 28.
Duck, goose, brant, coot, gallinule, Wilson snipe	Nov. 1-Jan. 31.
Black-bellied and golden plovers, yellowlegs, dove	Nov. 20-Jan. 31.
Woodcock	Nov. 1-Dec. 31.
Rail, other than coot and gallinule	Sept. 1-Nov. 30.
Reedbird (ricebird)	Aug. 16-Nov. 15. ²¹

No open season: Fawn, grouse, pheasant, turkey hen, introduced game birds, swans, wood duck, elder ducks, bitterns, sandhill and whooping cranes, gannet, grebes, gulls, herons, loons, petrels, shearwaters, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, \$15; resident, State \$3, county \$1 (good only in county of residence). License not required in militia district or to hunt on own or leased land. Issued by commissioner or county warden.

Bag limits and possession: Two deer, 2 turkeys a season; 15 cat squirrels, 25 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 6 woodcock, 25 in all of rails, coot, and gallinules, 25 doves a day. Possession of migratory birds except woodcock permitted during first 10 days of close season.

Sale: Sale of redbirds (ricebirds) and all protected game prohibited.

Export: Export of all protected game prohibited; provided, nonresident licensee may take out in personal possession game lawfully killed, but not more than 2 days' limit of migratory birds shall be exported in any one calendar week.

IDAHO.

Open seasons:	Dates inclusive.
Elk in Bingham, Bonneville, Fremont, and Teton Counties	Sept. 16-Dec. 15.
In Clearwater and Idaho Counties	Oct. 1-Nov. 15.
In game preserves and rest of State	No open season.
Deer, mountain goat in Adams, Blaine, Boise, Bonneville, Butte, Caribou, Clark, Custer, Elmore, Franklin, Gooding, Idaho, Jefferson, Lemhi, Lincoln, Madison, Power, Teton, Valley, and Washington Counties	Sept. 16-Nov. 30.
In game preserves and rest of State	No open season.
Quail in Ada, Cassia, Clearwater, Gem, Gooding, Idaho, Kootenai, Latah, Lewis, Lincoln, Nez Perce, and Owyhee Counties	Nov. 1-Nov. 15.
In rest of State	No open season.
Chinese, ringneck, and Mongolian pheasants in Ada, Canyon, Gem, Gooding, Latah, Lincoln, Nez Perce, and Twin Falls Counties	Nov. 1-Nov. 30.
In rest of State	No open season.
Partridge, pheasant, grouse in Benewah, Bonner, Boundary, Kootenai, and Shoshone Counties	Sept. 1-Oct. 31.
In Clearwater, Idaho, Latah, Lewis, and Nez Perce Counties	Aug. 15-Oct. 15.
Partridge or pheasant in Bannock, Bear Lake, Bingham, Bonneville, Butte, Caribou, Franklin, Fremont, Jefferson, Madison, Oneida, Power, and Teton Counties	Aug. 15-Sept. 15.

²¹ Georgia: See order of Secretary of Agriculture, p. 76.

Open seasons—Continued.

Dates inclusive.

- Ruffed and blue or dusky grouse in Adams, Bannock, Bingham, Blaine, Boise, Bonneville, Butte, Camas, Custer, Elmore, Frank-
lin, Fremont, Idaho, Lemhi, Madison, Teton, Valley, and Wash-
ington Counties.....Aug. 15—Sept. 30.
- Grouse (all kinds) in Ada, Canyon, Cassia, Clark, Gem, Gooding,
Jerome, Lincoln, Minidoka, Owyhee, Payette, and Twin Falls
Counties.....No open season.
- Franklin grouse (fool hen), sharp-tailed grouse (prairie chicken),
south of line between townships 24 and 25 north, range 2 west,
Salmon River and north boundary line Lemhi County.....No open season.
- Sage hen (State).....Aug. 15—Sept. 30.
- Doves.....Sept. 1—Sept. 30.
- Duck, goose, brant, Wilson snipe or jacksnipe, black-bellied and
golden plovers, yellowlegs, coot, and gallinule.....Sept. 16—Dec. 31.
- Rail, other than coot and gallinule.....Sept. 1—Nov. 30.
- No open season: Moose, antelope, caribou, sheep, buffalo, fawn, calf elk, prairie chicken,
plumbeous grouse (except as above), and imported pheasants (except Chinese, ring-
neck, and Mongolian pheasants as above), swans, wood duck, bitterns, little brown
and sandhill cranes, grebes, gulls, herons, loons, terns, and all shore birds (except
Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).
- Hunting and fishing licenses: Nonresident: Game and fish, \$10; bird, \$5; fish, \$2.
Alien: Game and fish, \$50; fish, \$10. Resident: Game and fish, \$1.50. Issued by
warden, deputy, or authorized agent. Fishing license not required of children under
12 or of women. No license required of resident women or of veterans of Civil War.
Persons under 12 prohibited from possessing gun afield.
- Bag limits and possession: One deer, 1 elk, 1 goat a season; 8 quail, 4 in all of Chinese,
ringneck, and Mongolian pheasants; 6 in all of partridge, pheasant, grouse, and sage
hen, and 12 mourning doves, a day or in possession; 18 ducks, 2 geese, 6 black-bellied
and golden plovers, 6 yellowlegs, 12 Wilson snipe, or a total of 20 in all a day or in
possession; 50 sora and 25 in all of other rails, coots, and gallinules a day.
- Sale: Sale of all protected game prohibited. Hides, heads, and horns may be sold under
permit.
- Export: Export of all protected game is prohibited; provided, any hunter may export,
under hunting license coupon, big game lawfully taken; big game once shipped within
State may be exported under a 50-cent permit obtained from game warden. Mounted
heads and stuffed birds legally secured may be exported.

FELENGES.

Open seasons:

Dates inclusive.

- Rabbit.....Nov. 1—Jan. 31.
- Squirrel.....July 1—Dec. 1.
- Quail (bob-white).....Nov. 16—Dec. 16.
- Prairie chicken.....Oct. 20—Oct. 31.
- Introduced pheasant (cocks).....Oct. 1—Oct. 5.
- Dove.....Sept. 1—Sept. 30.
- Duck, goose, brant, Wilson snipe, coot, gallinule, black-bellied and
golden plovers, yellowlegs.....Sept. 16—Dec. 31.
- Rail, other than coot and gallinule.....Sept. 1—Nov. 30.
- No open season: Deer (1925); wild turkey, introduced pheasant hen, sand grouse (1925);
ruffed grouse (partridge), blue, mountain, and valley quail, Hungarian partridge,
capercallie, heath hen, black grouse, woodcock (1925), swans, wood duck, elder ducks,
bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, jaegers,
loons, murres, petrels, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-
bellied and golden plovers, and yellowlegs).
- Hunting licenses: Nonresident, \$10.50; resident, \$1. Licenses not issued to aliens, nor to
minors under 16 without written consent of parent or guardian. Issued by village,
county, or city clerk. Owners, their children, and tenants in actual residence may
hunt during open season on own land without license. Permission required to hunt on
lands of another.
- Bag limits and possession: Ten squirrels, 15 rabbits, 12 quail, 3 prairie chickens, 2 cock
pheasants, 15 doves, 15 in all of black-bellied and golden plovers and yellowlegs, 15
snipe, 15 in all of coot and gallinules, 15 rail, but not more than 25 in all of rails.

²² Idaho: Residents of States adjoining Idaho having larger nonresident license fee
must pay fee charged in own State.

Bag limits and possession—Continued.

coots, and gallinules, 15 ducks, 8 geese, 8 brant a day. Limit in possession, 20 squirrels, 36 quail, 12 prairie chickens, 6 cock pheasants, 25 doves, 50 black-bellied and golden plovers and yellowlegs, 50 snipe, 60 coots and gallinules, 60 rail, 60 ducks, 10 geese, 10 brant.

Sale: Sale of all protected game (except rabbit during open season) prohibited.

Export: Export of all protected game (except rabbit) prohibited, except nonresident licensee may take from State 50 game birds or animals, if carried openly for inspection, but not more than 2 days' limit of migratory birds shall be exported in any one calendar week.

Holder of certificate may ship birds and game at any time for scientific or propagating purposes. (See Regulations 8 and 9, pp. 73-74.)

INDIANA.

Open seasons:	<i>Dates inclusive.</i>
Rabbit.....	Apr. 1-Jan. 10.
Squirrel.....	Aug. 1-Dec. 1.
Quail, ruffed grouse.....	Nov. 10-Dec. 20.
Prairie chicken.....	Oct. 15-Nov. 1.
Duck, goose, brant.....	Sept. 16-Dec. 31.
Woodcock.....	Oct. 1-Nov. 30.
Black-bellied and golden plovers, yellowlegs, Wilson snipe or jack-snipe, coot, gallinule.....	Sept. 16-Dec. 20.
Rail, other than coot and gallinule.....	Sept. 1-Nov. 30.

No open season: Deer, Hungarian partridge, introduced pheasant, wild turkey, dove, swans, wood duck, bitterns, sandhill and whooping cranes, gannet, grebes, gulls, herons, jaegers, loons, murrees, petrels, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: Game and fish, \$15.50; fish, \$1. Resident: game and fish, \$1. Issued by clerk circuit court. Not issued to person under 14 without written consent of parent or guardian. Civil War veterans and soldiers of the war with Germany require no license; owners of farm land, their children living with them, and tenants may hunt during open season on own land without a license. No license required of persons to fish in county of residence or contiguous counties. All children under 18 and wife of licensee may fish without license.

Bag limits and possession: Fifteen quail, 5 prairie chickens, 15 ducks, 8 geese, 8 brant a day; 45 waterfowl in possession as result of 3 or more days' consecutive hunting; 25 Wilson snipe, 6 woodcock, 50 sora, and 25 in all of other rails, coots, and gallinules, and 15 in all of plovers and yellowlegs a day. Possession of waterfowl permitted during first 10 days of close season.

Sale: Sale of quail, prairie chicken, introduced pheasants, Hungarian partridges, and migratory birds prohibited.

Export: Export of deer, quail, grouse, prairie chicken, pheasant, wild turkey, woodcock, duck, goose, brant, and other waterfowl prohibited, except nonresident may take from State 15 birds killed by himself (or 45 if he has hunted for 3 or more days consecutively) if carried openly for inspection together with license, but not more than two days' limit of migratory birds shall be exported in any one calendar week.

Miscellaneous: Shooting on highways or with searchlight prohibited.

IOWA.

Open seasons:	<i>Dates inclusive.</i>
Squirrel (gray, timber, or fox).....	Sept. 1-Jan. 1.
Ruffed grouse or pheasant, wild turkey.....	Nov. 1-Dec. 15.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule, black-bellied and golden plovers, yellowlegs.....	Sept. 16-Dec. 31.
Woodcock.....	Oct. 1-Nov. 30.
Rail, other than coot and gallinule.....	Sept. 1-Nov. 30.

No open season: Deer, elk, quail, prairie chicken, introduced pheasants, Hungarian partridge (1922); turtle dove, swans, wood duck, elder ducks, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, jaegers, loons, murrees, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident or alien, game, \$10; nonresident, fish, \$2 (required of males over 16 years of age. Resident citizen, \$1. Issued by county auditor. License not granted to persons under 18 without written consent of parent or guardian. Owners of farm lands, their children, and tenants, may hunt on own lands during open season without license. Unlawful to hunt on cultivated or inclosed lands of another without permission from owner.

Bag limits and possession: Twenty-five ducks a day, 50 in possession; 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 6 woodcock, 25 in all of rails, coots, and gallinules a day, 25 of each in possession. Twenty-five each of other birds and game a day or in possession. Possession of migratory birds permitted during first 10 days of close season; other game during first 5 days thereof.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited, except nonresident may take from State not more than 25 game birds or animals, if carried openly for inspection, and if hunting license be shown on request, but not more than two days' limit of migratory birds shall be exported in any one calendar week.

KANSAS.

Open seasons:	Dates inclusive.
Fox squirrel.....	Sept. 1-Jan. 1.
Quail.....	Dec. 1-Dec. 16.
Duck, goose, brant, Wilson snipe, coot, gallinule, black-bellied and golden plovers, yellowlegs.....	Sept. 16-Dec. 22.
Woodcock.....	Oct. 1-Nov. 30.
Rail, other than coot and gallinule.....	Sept. 1-Nov. 30.

No open seasons: Deer, antelope (1925); red, gray, and black squirrels, prairie chicken, ruffed grouse (partridge), pheasant (English, Mongolian, Hungarian) (1924); doves, swans, wood duck, elder ducks, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, loons, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, \$15. Issued by secretary of state. Resident, \$1. Issued by county clerk. Issued free to honorably discharged soldiers or sailors of United States. Resident landowner or member of family may hunt on own land during open season without a license. Unlawful to hunt on land of another or on highway or railroad right of way adjacent thereto without written consent of owner, unless accompanied by him.

Bag limits and possession: Twenty ducks, 10 quail, 12 Wilson snipe, 6 each of woodcock, geese, and brant, 50 sora and 25 in all of other rails, coots, and gallinules, and 15 in all of plovers and yellowlegs a day. Possession of migratory birds permitted during first 10 days of close season.

Sale: Sale of all protected game birds prohibited.

Export: Export of all protected game birds prohibited.

KENTUCKY.

Open seasons:	Dates inclusive.
Rabbit ²²	Nov. 15-Dec. 31.
Squirrel.....	July 1-Dec. 15.
Quail, ruffed grouse (native pheasant).....	Nov. 15-Jan. 1.
Dove.....	Sept. 1-Dec. 15.
Woodcock.....	Nov. 15-Nov. 30.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule, black-bellied and golden plovers, yellowlegs.....	Sept. 16-Dec. 31.
Rail, other than coot and gallinule.....	Sept. 1-Nov. 30.

No open seasons: Deer, elk (1925); introduced pheasants, Hungarian partridge, wild turkey (1924); swans, wood duck, bitterns, sandhill and whooping cranes, grebes, gulls, herons, jacksnipe, loons, petrels, terns, and all shore birds (except woodcock, Wilson snipe, black-bellied and golden plovers, and yellowlegs).

Hunting license: Nonresident or alien, \$7.50. Resident, \$1. Issued by county clerk. Resident landowner, tenant, and members of families may hunt on own land during open season without license. Unlawful to enter enclosed lands of another for shooting, hunting, or fishing without consent.

Bag limits and possession: Twelve quail a day, 12 in possession for each successive day of hunt; 15 doves a day, 15 in possession for each successive day of hunt; 2 ruffed grouse a day; 25 ducks, 8 geese, 8 brant, 6 woodcock, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 50 sora, and 25 in all of other rails, coot, and gallinules a day.

Sale: Sale of quail, partridge, grouse, introduced or native pheasant, Hungarian partridge, wild turkey, and migratory birds, wherever killed, prohibited.

Export: Export of deer, elk, and all game birds prohibited, except a hunter may transport game lawfully killed and possessed by him, but more than 2 days' limit of migratory birds shall not be exported in any one calendar week.

²² Kentucky: Rabbits may be taken with dogs or traps at any time for a person's own use on own land, but not for sale or barter.

LOUISIANA.

Open seasons:	Dates inclusive.
Deer (see exception)-----	Sept. 15-Jan. 5. ²⁴
<i>Exception:</i> South of Vernon, Rapids, Avoyelles, and Concordia Parishes, and Mississippi State line-----	
Bear-----	Oct. 1-Jan. 20.
Squirrel, chipmunk-----	Nov. 1-Feb. 15. ²⁵
Dove-----	Oct. 1-Mar. 1.
Quail, wild turkey (gobblers, Nov. 15-Mar. 15)-----	Oct. 16-Jan. 31.
Gros-bec (night heron)-----	Nov. 15-Feb. 15.
Duck, goose, brant, black-bellied and golden plovers, Wilson snipe, yellowlegs, rail, coot, gallinule-----	July 1-Nov. 1.
No open season: Fawns, elk, prairie chicken, introduced pheasant, upland plover (papa-botte) (1922); woodcock (1923); swans, wood duck, bittern, sandhill and whooping cranes, gannet, grebes, gulls, herons, loons, petrels, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-bellied and golden plover, and yellowlegs).	Nov. 1-Jan. 31.
Hunting licenses: Nonresident or alien, \$15; resident, \$1. Issued by tax collectors. Non-resident or alien not permitted to hunt for profit. A person may hunt during open season without a license on land owned or leased for agricultural purposes. License does not authorize hunting on land of another without his written consent.	
Bag limits and possession: Two deer a day or in possession, 5 a season; 15 squirrels and chipmunks, 15 quail, 1 turkey, 25 doves, 25 ducks; 8 geese, 8 brant, 10 in all; 25 in all of rails, coots, and gallinules; 15 gros-becs; 15 in all of plovers and yellowlegs; 25 Wilson snipe and 15 other birds in all a day. Possession permitted during first five days of close season.	
Sale: Sale of all game (except squirrels and rabbits during open season) prohibited.	
Export: Export of all protected game prohibited, except under permit for scientific or educational purposes; provided, a nonresident licensee may carry with him out of the State under his license one day's limit of game, if not for sale. Bears may not be exported, except under written permission of conservation department.	

MAINE.²⁶

Open seasons: ²⁷	Dates inclusive.
Deer (see exception)-----	Oct. 1-Nov. 30.
<i>Exception:</i> In Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Sagadahoc, Waldo, and York Counties-----	
Bull moose-----	Nov. 1-Nov. 30.
Hare, rabbit-----	Nov. 21-Nov. 30.
Gray squirrel-----	Oct. 1-Mar. 31.
Ruffed grouse, partridge, woodcock (see exception)-----	Oct. 1-Oct. 31. ²⁸
<i>Exception:</i> In Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Sagadahoc, Waldo, and York Counties-----	
Duck, goose, brant, Wilson snipe, coot, gallinule-----	Oct. 1-Oct. 31.
Black-bellied and golden plovers, yellowlegs-----	Sept. 16-Dec. 31.
Rail, other than coot and gallinule-----	Aug. 16-Nov. 30.
No open season: Deer on Cross, Scotch, Swan, and Mount Desert Islands, and in towns of Deer Isle, and Stonington, in Hancock County, and in Isle au Haut, in Knox County, cow and calf ²⁹ moose, caribou, quail, Hungarian partridge, pheasant, black game, capercaillie, cock of the woods, dove, swans, wood duck, elder ducks, auks, bitterns, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murrelets, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).	Sept. 1-Nov. 30.

²⁴ Louisiana: Deer season fixed by conservation commissioner.

²⁵ Nonresidents coming into State to hunt bears must report in writing to conservation department before arrival at destination.

²⁶ Maine: Commissioner may make local regulations and governor may suspend hunting seasons during drought.

²⁷ All hunting is prohibited on Kineo Point, Piscataquis County; on Back Bay above Grand Trunk Railroad bridge, and on Richmonds Island, Cumberland County; southern point Swan Island; and locally in town of Eden, Hancock County, and town of Scarborough, Cumberland County. (See State laws for details and other protected areas.)

²⁸ Squirrels protected in parks and in compact or built-up portions of cities and villages.

²⁹ Term applies to animals under 1 year of age and which do not have at least two 3-inch prongs to each horn.

Hunting and Fishing Licenses: Nonresident hunting licenses: Moose, \$25; deer and other game, October 1-December 31, \$15; birds, prior to October 1 in Aroostook, Franklin, Hancock, Oxford, Penobscot, Piscataquis, Somerset, and Washington Counties, \$5; season (except November) in rest of State (8 southern counties), \$5. For November (in southern counties), a \$15 license, or, if moose are to be hunted, a \$25 license is required. Holder of a license may exchange it for a license for which a larger fee is required by paying the difference in cost. Nonresident must be accompanied by registered guide when camping and kindling fires while hunting or fishing on wild lands (land in unorganized or unincorporated townships) prior to November 30. Nonresident or resident alien, fishing license, \$2.15 (not required of children under 14 years of age). Resident alien, game, \$15 (not required of aliens who pay taxes on real estate and who have resided in State two years continuously prior to application). Guide licenses: Nonresident, \$20; resident, \$1. Must not guide more than five persons hunting at one time. Shipping licenses (within State): Resident, deer, \$2; one pair of game birds in seven days, 50 cents. Issued by commissioner.

Resident hunting license, see 25 cents. Not required of resident or member of immediate family for hunting during open season on own land used exclusively for agricultural purposes and on which he is actually domiciled. License valid as long as holder remains citizen of State. Issued by city, town, and plantation clerks.

Bag limits and possession: Two deer (except in Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Sagadahoc, Waldo, and York Counties, limit 1), 1 bull moose a season; 5 ruffed grouse, 10 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs but not more than 5 plovers, 10 Wilson snipe, 6 woodcock, 50 sora and 25 in all of other rails, coot, and gallinules a day. Transportation of migratory game birds must be completed within five days after close of season; reasonable time allowed after close of season to transport other game to home of owner. Possession of migratory birds limited to first 10 days of close season; deer legally secured may be possessed during close season.

Sale: Sale of all protected game birds prohibited; sale of bull moose or deer for export prohibited. Local provision dealer, under \$5 license, may purchase 2 deer and 1 bull moose for retail to his customers. Deer skins and skins with heads attached may be bought and sold by residents under \$25 license. Heads when detached from skins with which purchased may be sold to licensed taxidermists.

Export: Export of all protected game prohibited; provided, a resident of the State, under shipping license, may export 5 partridges, 10 woodcock, and 10 ducks (fee \$5) lawfully killed by himself. A nonresident may export, open to view under hunting-license tags, 2 deer and 1 bull moose, 5 partridges, 10 ducks, and 10 woodcock, lawfully killed by himself, upon identifying same at shipping point; nonresident licensee may also ship out one pair of game birds a month under a special 50-cent license. Live game may be exported for breeding and advertising purposes under permit of the commissioner of inland fisheries and game.

Miscellaneous: Unlawful to possess rifle or shotgun, either loaded or with a cartridge in the magazine thereof, in or on any motor vehicle while upon any highway or in the fields or forests.

MARYLAND.

Open seasons:

Dates inclusive.

Rabbit, squirrel, quail (partridge), ruffed grouse (pheasant), male introduced pheasant, wild turkey	Nov. 10-Jan. 1.
Woodcock	Nov. 10-Dec. 31.
Dove	Sept. 1-Dec. 15.
Duck, goose, brant, Wilson snipe, coot, gallinule	Nov. 1-Jan. 31. ²⁰
Black-bellied and golden plovers, yellowlegs	Aug. 16-Nov. 30. ²⁰
Rail, other than coot and gallinule	Sept. 1-Nov. 1.
Reedbird	Sept. 1-Oct. 30. ²⁰

²⁰ *Maryland:* Wild fowl shooting restricted locally as follows: On the Susquehanna Flats north of a line extending from Turkey Point Lighthouse, Cecil County, and half a mile north of Specutia Island to Oakington, Harford County, hunting allowed only on Mondays, Wednesdays, and Fridays, Nov. 1-Jan. 1, and Mondays, Wednesdays, Fridays, and Saturdays, Jan. 1-Jan. 31; in Harford County only before 2 p. m.; in Anne Arundel County, on Magothy River on Tuesdays, Thursdays, and Saturdays; on Rhode and West Rivers on Mondays, Wednesdays, and Fridays; on Severn River on Mondays, Wednesdays, and Saturdays; in Cecil County, on Bohemia, Elk, and Sassafras Rivers on Mondays, Wednesdays, Fridays, and Saturdays; in Dorchester County, on Choptank River on Tuesdays, Thursdays, and Saturdays; in Kent County, on Chester River above Cliff City and Spaniard Point on Mondays, Fridays, and Saturdays; in St. Marys County, on Wicomico River and tributaries on Tuesdays, Thursdays, and Saturdays.

²¹ See Order of the Secretary of Agriculture, p. 76.

No open season: Deer, elk (1922); introduced pheasant hens, swans, wood duck, elder ducks, auks, bitterns, sandhill crane, gannet, grebes, gulls, herons, jaegers, loons, murre, petrels, shearwaters, terns, and all shorebirds (except woodcock, Wilson snipe or Jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, \$10.25 (fee \$5.25 for State license if applicant owns real estate in Maryland assessed at \$500; \$1.25 for county license in county where such real estate is located); resident, State, \$5.10; county, \$1.10; issued by clerks of circuit court—in Baltimore city by clerk, court of common pleas. License not issued to person under 14 years of age without written request of parent or guardian. Owners, tenants, and their children may hunt on own land during open season without license. Patuxent River Club license, \$25; issued by clerk of circuit court.

Sinkbox, sneak boat, blind, pusher.—*Cecil:* Sneak boat (Bohemia and Elk Rivers), \$5.50; sinkbox (Bohemia, Elk, and Sassafras Rivers), \$10.50. *Anne Arundel:* Pusher, \$2; booby and brush blinds (west side Chesapeake Bay), \$5; (South River), \$2.50. *Harford:* Sinkbox, \$20.75; sneak boat, \$5.75. *Kent:* Sinkbox, \$20; blind, \$5. *Queen Anne:* Sinkbox, \$10.50; sneak boat, \$5.75; booby blind, \$2.50. *Susquehanna Flats:* Sinkbox, \$20.75; sneak boat, \$5.75. *Talbot:* Sinkbox or blind, \$5 (issued to county resident only). *Patuxent River:* Pusher, \$2.50 (required of residents to push or paddle nonresidents); blind, \$5.25 (not required in St. Marys County).

Bag limits and possession: Four wild turkeys a season; 10 rabbits, 10 squirrels, 12 quail (partridge), 2 ruffed grouse, 3 English pheasants, 6 woodcock, 12 doves, 10 Jacksnipe, 15 yellowlegs, 5 black-bellied plover, 15 golden plover (but not more than 15 plovers and yellowlegs combined), 50 reedbirds, 50 sora, 25 in all of other rails, coots, and gallinules (but not more than 10 coots and gallinules or 50 sora and other rails combined), 25 waterfowl (but not more than 8 geese and 8 brant) a day for each licensed gunner (not exceeding 4) connected with an outfit. Possession of waterfowl, Wilson snipe, and plovers permitted during first 10 days of close season, and of doves until December 24.

Additional county restrictions: Allegany, 2 wild turkeys a day. Baltimore, 6 rabbits, 1 jack rabbit, 8 squirrels, 10 quail, 1 English pheasant, 1 ringneck pheasant, 1 wild turkey a day. Calvert, 6 rabbits a day. Cecil, 5 rabbits, 6 squirrels, 50 blackbirds a day. Frederick, 8 rabbits, 5 woodcock a day. Garrett, 2 ruffed grouse, 3 English pheasants, 6 other game birds a day. Harford, 6 rabbits, 1 jack rabbit, 8 squirrels, 10 quail, 5 woodcock, a day or in possession.

Sale: Sale of quail, ruffed grouse, wild turkey, introduced pheasant, and doves, reedbirds, and all other migratory game birds is prohibited. The sale of other game is prohibited under county laws, as follows:

Allegany—Deer, squirrel, hare.

Baltimore—Rabbit, squirrel, for export.

Calvert—Rabbit, for export for sale.

Carroll—Squirrel.

Cecil—All protected game (except rabbit).

Dorchester—Rabbit, squirrel, for export.

Frederick—Rabbit, squirrel, taken in county.

Harford—Rabbit, squirrel (for sale).

Montgomery—Rabbit for export.

Somerset—Rabbit, dead or alive, for any other purpose than as food within the county or for propagation; or any game for export.

Washington—All game.

Worcester—Rabbit (except to consumer).

Export: Export of all protected game (except waterfowl) prohibited; provided, a licensed hunter may take out under his license an amount equal to one day's bag limit of game, if not for sale; provided, further, no person may take out more than 50 ducks, 16 geese, and 16 brant in any one calendar week.

County provisions prohibiting export are as follows:

Allegany—All protected game (for sale).

Anne Arundel—All protected game, viz: Squirrel, rabbit, quail, partridge, pheasant, woodcock, snipe, plover, duck, goose, brant from county.

Baltimore—Rabbit, squirrel, quail, partridge, pheasant, dove, woodcock from county.

Calvert—Rabbit, partridge, woodcock from county (for sale, barter, or trade).

Carroll—Squirrel, quail, pheasant, dove, woodcock.

Exception: Twelve squirrels, 10 quail, 3 pheasants, 12 doves, 6 woodcock, by guest of landowner or nonresident licensee as personal baggage and not for sale.

Caroline—Rabbit, quail, partridge, woodcock from county.

Cecil—Squirrel, quail, grouse, woodcock, plover from county.

Export—Continued.

Dorchester—All protected game.

Exception: Twelve quail or partridges, 6 each of squirrels, rabbits, woodcock, and doves may be taken out of the county at one time as personal baggage, if carried openly and not intended for sale.

Frederick—Rabbit, squirrel, partridge, pheasant, woodcock from county (for sale). Garrett—Partridge, pheasant, wild turkey, woodcock from State.

Exception: Rabbit, if shipped openly, Nov. 10–Dec. 25. Nonresident may take out game killed under his hunting license.

Harford—Rabbit, squirrel, quail.

Exception: Nonresident licensee may take out 6 rabbits, 1 jack rabbit, 8 squirrels, 10 quail, 5 woodcock, 10 jacksnipe, 50 rails for private use.

Kent—Squirrel, rabbit, and all birds from county (for sale, except under license).

Montgomery—Rabbit, partridge, quail, woodcock from county (for sale).

Exception: Nonresident licensee may take out game lawfully killed.

Queen Anne—Rabbit, partridge, woodcock from county (for sale).

Somerset—All game, viz: Squirrel, rabbit, quail or partridge, pheasant, dove, woodcock, duck, goose from county.

Talbot—All game.

Exception: Six rabbits, 6 squirrels, 12 quail, 6 doves, 6 woodcock may be taken out if not for sale.

Washington—Deer, squirrel, rabbit, partridge, pheasant, dove, woodcock, turkey from county (for sale).

Wicomico—Quail or partridge, Wicomico and Worcester Counties considered as one territory.

Worcester—Rabbit, quail, woodcock from county.

MASSACHUSETTS.

Open seasons:—

Dates inclusive.

Deer (first Monday in December to the following Saturday, inclusive)-----Dec. 6–Dec. 11.

Hare (known as varying or Canada hare or snowshoe or white rabbit) or rabbit (see exceptions)-----Oct. 20–Jan. 31.

Exceptions: Hare or white rabbits in Barnstable, Dukes, Nantucket, and Norfolk Counties, 1923; European hares in Berkshire County, unprotected.

Gray squirrel, quail, ruffed grouse, woodcock (see exception)-----Oct. 20–Nov. 20.

Exception: Quail in Dukes, Essex, Hampden, Middlesex, and Nantucket Counties (1922).

Duck, goose, brant, Wilson snipe, gallinule, quark (mudhen)-----Sept. 16–Dec. 31.

Black-bellied and golden plovers, yellowlegs-----Aug. 16–Nov. 30.

Rail, other than coot and gallinule-----Sept. 1–Nov. 30.

No open seasons: Moose, dove, prairie chicken, Hungarian partridge, pheasants (English, golden, Mongolian),²² heath hen, swans, wood duck, elder ducks, auks, bitterns, sandhill and whooping cranes, fulmars, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murrelets, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing²³ licenses: Nonresident citizen: General, \$10; fish, \$1. Members of incorporated game clubs owning real estate assessed at not less than \$500 for each member, and which were organized prior to 1907; owners, or their minor children over 18 years old, of real estate assessed at not less than \$500; or nonresidents invited (for not more than four days) by members of incorporated club for hunting foxes pay a fee of \$1. Resident citizen: General, \$1; fish, 50 cents. License not issued to minors under 15, and those under 18 years of age must apply in writing and furnish written consent of parent or guardian. A license (fee 25 cents) to trap quadrupeds, in discretion of issuing officer, may be issued to any minor who is a citizen between the ages of 12 and 18. License not required of resident for hunting on own land used exclusively for agricultural purposes and on which he is actually domiciled, nor of women or minors under 18 to fish. Alien: General, \$15; fish, \$1 (applicant must own real estate to the assessed value of \$500). Issued by city or town clerks.

Bag limits and possession: One deer a season; 2 hares and 5 rabbits a day or in possession (imported hares, legally taken, may be possessed in Barnstable, Dukes, Nantucket, and Norfolk Counties); 5 gray squirrels a day, 15 a season; 4 quail a day, 20 a

²² Massachusetts: Governor may suspend open seasons during extreme drought.

²³ Commission may open season on pheasants.

²⁴ License required to fish in inland waters which have been stocked with fish by the commission since January 1, 1910.

Bag limits and possession—Continued.

season; 3 ruffed grouse a day, 15 a season; 2 pheasants a day, 6 a season; 4 woodcock a day, 20 a season; 25 ducks (not more than 15 black ducks), 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 50 sora, and 25 in all of other rails, coots, and gallinules a day. Possession of waterfowl in counties of Barnstable, Bristol, Dukes, and Nantucket, and of plovers, yellowlegs, and rails permitted during first 10 days of close season.

Sale: The sale of all game (except rabbit) is prohibited; provided, deer, moose, caribou, and elk lawfully killed and imported into the State under warden's tag may be sold under license at any time. Dealers may sell under license unplucked bodies of pheasant, Scotch grouse, European black game, red-legged partridge, and Egyptian or migratory quail imported from without the United States. The above game must be tagged; fee, 5 cents a tag. Hares or rabbits lawfully secured and imported from a State or country where their sale is not prohibited and rabbits lawfully taken in State may be sold during the open season, except hares in Barnstable, Dukes, Nantucket, and Norfolk counties. Live quail under State permit and waterfowl under Federal and State permits may be sold for propagation.

Export: Export of quail and ruffed grouse taken in State and of all migratory game birds prohibited; provided, a nonresident under his license may take 10 in all of wild fowl and quail into another State according similar privilege, if carried open to view and the commission or district deputy is notified; provided further, a resident may export all game (except quail, ruffed grouse, woodcock), but more than two days' bag limit of migratory birds may not be exported in any one calendar week. No game illegally taken may be exported.

Miscellaneous: Deer may be taken with a shotgun only. Unlawful to hunt or kill game with rifle or revolver during open season for deer.

MICHIGAN.**Open seasons:**²⁵*Dates inclusive.*

Deer (see exceptions).....	Nov. 10–Nov. 30.
<i>Exceptions:</i> Deer in red coat, fawn in spotted coat; all deer in Antrim, Arenac, Bay, Charlevoix, Cheboygan, Clare, Crawford, Emmet, Gladwin, Grand Traverse, Huron, Kalkaska, Lake, Manistee, Mason, Midland, Missaukee, Newaygo, Oceana, Ogemaw, Osceola, Oscoda, Otsego, Roscommon, Sanilac, Tuscola, and Wexford Counties (1923).	
Rabbit (see exception).....	Oct. 1–Mar. 1.
<i>Exception:</i> South of township 21 north.....	Nov. 1–Mar. 1.
Squirrel (fox).....	Oct. 15–Oct. 31.
Ruffed grouse (partridge) (see exception).....	Oct. 1–Oct. 31.
<i>Exception:</i> Lower Peninsula.....	Nov. 1–Nov. 30.
Woodcock.....	Oct. 1–Nov. 25.
Duck, goose, brant, Wilson snipe, coot, gallinule.....	Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs.....	Sept. 16–Dec. 15.
Rail, other than coot and gallinule.....	Sept. 16–Nov. 30.
No open season: Elk, moose, caribou, European partridge, dove, squirrel (except fox squirrel), quail, introduced pheasants, black game, capercaillie, hazel grouse, Canada or spruce grouse, prairie chickens, wild turkey (1921); swans, wood duck, elder ducks, auks, bitterns, sandhill and whooping cranes, gannet, grebes, gulls, herons, jaegers, loons, murrets, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).	
Hunting licenses: ²⁶ Nonresident or alien: Deer, \$25; small game, \$10. Resident: Deer, \$1.50; small game, \$1. Issued by county clerks, commissioner, or deputy. Licenses issued to persons under 17 and over 12 on application of parent or guardian, who must accompany such minor when hunting. No license required of residents or minor children hunting small game on own inclosed land on which they reside.	
Bag limits and possession: One deer a season, 5 partridge a day, 10 in possession, 25 a season; 25 ducks and coots a day or in possession, 50 a calendar week; 6 geese and brant a day or in possession, 25 a season; 6 woodcock a day, 20 in possession, 25 a season; 15 Wilson snipe a day, 25 a season; 15 in all of black-bellied and golden plovers and yellowlegs a day, 25 a season; 50 sora and 25 in all of other rails, coots, and gallinules a day. Possession of migratory birds permitted during first 10 days of close season, and other game during first 30 days thereof. Camping party of six or	

²⁵ *Michigan:* Seasons may be shortened or closed by order of commissioner.

²⁶ *Fishing licenses:* Nonresident (over 21), general, \$3; special, \$1 (fish, except brook trout).

Bag limits and possession—Continued.

not less than four licensed hunters maintaining a camp of not less than four persons for not less than seven days may, under permit (fee \$3), kill one deer for camp purposes.

Sale: Sale prohibited of all protected game, except rabbit; provided, deer skins and green or mounted buck-deer heads lawfully taken may be sold under permit. Dealers may sell under license unplucked carcasses of pheasants of all species, Scotch grouse, European black game, red-legged partridge, Egyptian quail, European red deer, fallow deer, roe buck, and reindeer lawfully imported from another State or country, if properly tagged on arrival in State. Licensed retail dealer, club, hotel, restaurant, etc., may sell portion of said imported and tagged game to patron or customer for actual consumption or use.

Export: Export prohibited of all protected game.

Exceptions: (1) Deer may be transported outside the State to reach a point within the State.

(2) Nonresident licensee may take out, as hand baggage, open to view, 1 day's bag limit of birds, and may ship one deer when license tag and seal are attached, if permit on back of license coupon is canceled by agent at initial point of billing.

(3) Deer skins and green or mounted buck-deer heads may be exported under permit.

MINNESOTA.**Open seasons:**²⁷**Dates inclusive:**

Deer, bull moose.....	Nov. 15-Dec. 5.
Black bear, rabbit (see exception).....	Unprotected.
<i>Exception:</i> Varying hare, or snowshoe rabbit.....	
Squirrel (gray, black, or fox).....	Oct. 15-Mar. 1.
Quail.....	Oct. 15-Mar. 1. ²⁸
Ruffed grouse or partridge (1920, 1922).....	Oct. 15-Nov. 30.
Dove.....	Oct. 15-Nov. 30.
Woodcock.....	Sept. 16-Oct. 1.
Duck, goose, brant, coot, gallinule, Wilson snipe or jacksnipe yellowlegs.....	Oct. 1-Nov. 30.
Rail, other than coot and gallinule.....	Sept. 16-Dec. 31.
	Sept. 16-Nov. 30.

No open season: Elk, cow moose, caribou, upland plover, imported pheasant, prairie chicken, pinnated, white-breasted, and sharp-tailed grouse (1922); black-bellied and golden plovers, swans, wood duck, elder ducks, auks, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, jaegers, loons, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe and yellowlegs).

Hunting and fishing licenses: Nonresident or alien: Animals, \$50; birds, \$15. Issued by commissioner. Fishing license, \$1 (not required of person under 16 years of age). Issued by commissioner, county auditors, game wardens, and agents. Resident: Animals, \$1; birds, \$1; fish house, \$1. Issued by county auditor. Not issued to person under 14 years of age. Owners, lessees, or members of their immediate families may hunt birds without license during open season on own or leased land occupied by them as permanent residence. Unlawful to enter growing grain fields for purpose of hunting without permission of owner.

Bag limits and possession: One deer or 1 antlered moose (but not both) a season; 5 geese a day or in possession; 15 in all of ducks, coots, gallinules, Wilson snipe or jacksnipe, yellowlegs, and rails a day, 45 in possession; 10 quail, 5 ruffed grouse a day, 20 in possession, 30 a season. Possession permitted during first 5 days of close season. Under permit or tags deer and moose may be possessed to February 28, migratory birds for 10 days after close of season, and other game birds to January 31.

Sale: Sale of all protected game prohibited; provided, hides of deer and moose legally killed may be sold.

Export: Export of all protected game prohibited, except nonresident licensee may ship home in open season under his license coupons 1 deer, or 1 bull moose, and 25 birds lawfully taken by himself, but not more than 2 days' limit of migratory birds may be exported in any one calendar week. Deer and moose hides for tanning and heads for mounting may be exported when tagged with license coupons.

Miscellaneous: Unlawful to carry gun in motor vehicle unless taken apart or contained in a case. Unlawful to keep game in cold storage.

²⁷ Minnesota: All hunting prohibited within 3 miles of the corporate limits of Duluth, Minneapolis, and St. Paul.

²⁸ Squirrels protected within corporate limits of any city or village, or within one-fourth mile thereof.

MISSISSIPPI. ²⁰

Open seasons: ²⁰	Dates inclusive.
Deer (male), bear.....	Nov. 15-Mar. 1.
Rabbit, squirrel.....	Unprotected.
Quail or partridge.....	Nov. 1-Mar. 1.
Wild turkey gobblers.....	Jan. 1-May 1.
Dove.....	Oct. 16-Jan. 31.
Waterfowl, Wilson snipe or jacksnipe, coot, poule d'eau, gallinule, black-bellied and golden plovers, yellowlegs.....	Nov. 1-Jan. 31.
Woodcock.....	Nov. 1-Dec. 31.
Rail, other than coot and gallinule.....	Sept. 1-Nov. 30.
No open season: Does; turkey hens (1921); swans, wood duck, bitterns, sandhill crane, grebes, gulls, herons, loons, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).	
Hunting licenses: Nonresident, \$20 (county license). Issued by sheriff. Landowners and their nonresident relatives and friends may hunt without license during open season on own lands.	
Bag limits and possession: One deer a day, 5 a season; 20 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 6 woodcock, 20 doves, 15 in all of rails, coots, and gallinules, but a mixed bag shall not exceed 20 birds. Possession of migratory birds permitted during first 10 days of close season.	
Sale: Sale of all protected game prohibited.	
Export: Export of all protected game prohibited.	

MISSOURI.

Open seasons:	Dates inclusive.
Deer (buck).....	Nov. 1-Dec. 31.
Squirrel.....	June 1-Dec. 31.
Quail (bob-white partridge).....	Nov. 10-Dec. 31. ²¹
Wild turkey.....	Dec. 1-Dec. 31.
Duck, goose, brant, Wilson snipe, coot, gallinule, black-bellied and golden plovers, yellowlegs.....	Sept. 16-Dec. 31.
Woodcock.....	Nov. 10-Nov. 30.
Rail, other than coot and gallinule.....	Sept. 15-Nov. 30.
No open season: Does, fawns under 1 year of age, ruffed grouse (pheasant), prairie chicken (pinnated grouse), imported pheasants, other introduced game birds, dove; swans, wood duck, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, jaegers, loons, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).	
Hunting and fishing licenses: Nonresident or alien, \$10; fish only, \$3. Issued by commis- sioner. Resident, State, \$2.50; county, \$1, good in county of residence or adjoining county; fish only (State), \$1. Issued by county clerk or license collector. Fishing license not required in county of residence nor of women and minors who are citizens. Owners and tenants of agricultural lands and members of family under 21 may hunt without license during open season on own or leased land. Hunting on land of an- other prohibited without his consent.	
Bag limits and possession: One deer, 4 turkeys a season; 1 turkey, 10 quail, 15 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 15 Wilson snipe a day; 15 rails, 15 coots, 15 gallinules, but not more than 25 in all a day or in possession; or 2 tur- keys, 15 quail, 25 of any other species of birds in possession. Possession of migratory birds, except doves, permitted during first 10 days of close season; other game during first 5 days thereof.	
Sale: Sale of all protected game prohibited.	
Export: Export of all protected game prohibited, except game may be exported under resident or nonresident license if carried openly as baggage or express or in owner's possession and accompanied by him, but more than 2 days' limit of migratory birds may not be exported in any one calendar week. Export (except of quail) for scien- tific or propagating purposes allowed under permit.	

²⁰ *Mississippi:* Local regulations of boards of supervisors may also be in force, but those relating to migratory birds must not be inconsistent with Federal regulations.

²¹ *Missouri:* Upon petition of 100 householders to the county court, at any regular or special term thereof, more than 30 days before a general election to be held in such county, the question of a close season on quail for the next two years in such county may be submitted to the qualified voters therein at the election.

MONTANA.

Open seasons:

Dates inclusive.

Deer (see exception)-----	Oct. 1-Nov. 30.
<i>Exception:</i> Deer in Custer, Dawson, Richland, Rosebud, and Yellowstone Counties (1922); in Roosevelt, Sheridan, and Valley Counties (1921).	
Elk in Carbon, Madison, Park, Stillwater, Sweet Grass, and parts of Beaverhead and Gallatin Counties-----	Oct. 15-Dec. 24.
In Fergus, Mineral, Wheatland, Ravalli, and parts of Granite, Lewis and Clark, and Powell Counties-----	Oct. 15-Oct. 24.
In Flathead, Lincoln, Teton, and parts of Granite and Missoula Counties-----	Oct. 15-Nov. 30.
Pheasant, partridge, prairie chicken, sage hen, fool hen, grouse (see exception)-----	Sept. 15-Sept. 30.
<i>Exception:</i> In Roosevelt, Sheridan, and Valley Counties-----	
Duck, goose, brant-----	Oct. 1, 1921.
Black-bellied and golden plovers, Wilson snipe or jacksnipe, yellowlegs, coot, gallinule-----	Sept. 16-Nov. 30.
Rail, other than coot and gallinule-----	Sept. 16-Dec. 31.
	Sept. 1-Nov. 30.

No open season: Sheep, goat (1922); elk (except as above), moose, caribou, antelope, bison or buffalo, quail, introduced pheasant, dove, swans, wood duck, bittern, little brown, sandhill, and whooping cranes, grebes, gulls, herons, loons, band-tailed pigeon, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: General, \$50; birds and fish, \$15; fish, \$3. Alien: General, \$50; fish, \$5. Resident: General, \$1.50. Guide (resident), \$10. Shipping (export), 50 cents. Issued by warden or deputy. Elk (special), \$25 (2 elk in Park and Gallatin Counties). Issued by warden.

No license required of female under 16 or of male under 14. Alien not holding a hunting license required to obtain from warden \$25 license to possess firearms.

Bag limits and possession: One deer, 1 elk a season except in Gallatin and Park counties where 2 elk may be taken under special \$25 license; 5 in all of grouse, partridges, prairie chickens, fool hens, pheasants, and sage hens a day or in possession; 20 ducks, 8 geese, 8 brant, 15 in all of plovers and yellowlegs, 25 Wilson snipe, 50 sora, 25 in all of other rails, coot, and gallinules a day. Possession of migratory birds except waterfowl permitted during first 10 days of close season.

Sale: Sale of all protected game prohibited; provided, merchant or hotel or restaurant keeper may sell game, except migratory birds, killed outside the State. Under permit mounted specimens or hides or heads of game animals or birds lawfully taken may be sold.

Export: Export of all protected game prohibited; provided, game lawfully killed may be exported in open season under hunting license, and shipping permit (fee, 50 cents) from State warden; total shipments under one license may not exceed season's bag limit, and not more than 2 days' limit of migratory birds may be exported in any one calendar week; packages to be labeled to show contents.

NEBRASKA.

Open seasons:

Dates inclusive.

Squirrel (gray, red, fox, timber)-----	Oct. 1-Nov. 30.
Prairie chicken, sage chicken, grouse-----	Oct. 15-Nov. 15.
Duck, goose, brant, Wilson snipe or jacksnipe, yellowlegs, coot gallinule-----	Sept. 16-Dec. 31.
Rail, other than coot and gallinule-----	Sept. 1-Nov. 30.

No open season: Deer, elk, antelope, quail, partridge, pheasant, ptarmigan, introduced game birds, dove, wild turkey, plovers, woodcock, swans, wood duck, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, jaegers, loons, terns, and all shorebirds (except Wilson snipe or jacksnipe and yellowlegs).

Hunting and fishing licenses: Nonresident: General, \$10; fish, \$2. Resident, \$1. Issued by commissioner or county clerk. Owner or lessee may hunt and fish without license during open season on lands on which he resides. No license required by male under 18 if accompanied by parent or guardian; male under 18 and female may fish without license. Hunting on land of another without permission or from highways prohibited.

Bag limits and possession: Ten squirrels, 10 prairie chicken or grouse, 25 ducks a day; 8 geese, 8 brant a day, 10 in all in possession; 25 Wilson snipe, 15 in all of plovers and yellowlegs, 50 sora, and 25 in all of other rails, coots, and gallinules a day; 20 squirrels, 10 prairie chickens or grouse, 10 wild geese or brant, or 50 in all of other game birds in possession. Possession permitted during first 5 days of close season.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited, except nonresident may ship 50 birds out of State in a season under hunting license, but must give common carrier invoice of number and kinds of birds, must have details of shipment marked on license, and must accompany the shipment, but more than 2 days' limit of migratory birds may not be exported in any one calendar week; package to be labeled to show contents and name and address of owner or consignor.

NEVADA.

Open seasons: ^a	Dates inclusive.
Deer	Oct. 15–Nov. 15.
Prairie chicken	Oct. 1–Jan. 15.
Sage hen	July 15–Sept. 1.
Dove	Sept. 1–Dec. 15. ^a
Duck, goose, brant, coot, gallinule, Wilson snipe or jacksnipe, black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 31.
Rails, other than coot and gallinule	Sept. 1–Nov. 30.
No open season: Elk, antelope, sheep, goat (1930); mountain quail, grouse (1922); pheasant; ^a swans, wood duck, bitterns, little brown and sandhill cranes, grebes, gulls, herons, loons, murres, band-tailed pigeon, terns, and all shore birds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).	
Hunting and fishing licenses: Nonresident: Game, \$5; fish, \$5. Alien: Fish, \$15. Resident citizen: Game, \$1; fish, \$1. Issued by county clerks and wardens. Aliens prohibited from hunting. No license required of boys or girls under 14. Landowners may hunt and fish on own land without license during open season.	
Bag limits and possession: One deer a season; 10 sage hens, 15 ducks, 5 geese, 5 brant, 15 snipe a day or in possession; 15 in all of plovers and yellowlegs, 50 sora, and 25 in all of other rails, coots, and gallinules, and 25 doves a day. Possession of migratory birds permitted during first 10 days of close season.	
Sale: Sale of all protected game prohibited.	
Export: Export of all protected game prohibited.	

NEW HAMPSHIRE.

Open seasons: ^a	Dates inclusive.
Deer in Coos County	Oct. 15–Dec. 15.
In Carroll (except town of Moultonborough) and Grafton Counties	Nov. 1–Dec. 15.
In rest of State	Nov. 15–Dec. 15.
Hare, rabbit	Oct. 1–Feb. 28.
Quail, partridge, ruffed grouse, woodcock	Oct. 1–Nov. 30.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule	Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 30.
Rails, other than coot and gallinule	Sept. 1–Nov. 30.
No open season: Elk, moose, caribou, dove, pheasant, European partridge; gray squirrel (1924); swans, wood duck, elder ducks, auks, bitterns, sandhill crane, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).	
Hunting and fishing licenses: Nonresident: Game and fish, \$15; fish, \$1. Resident: Game and fish, \$1. Resident soldiers and sailors over 70 years of age may hunt and fish without a license. Fishing licenses not required of children under 16 years of age, nor of women or blind people. Issued by commissioner or his agent in each town, who with few exceptions is the town clerk. Licenses not granted to children under 13 years of age, and only with written consent of parent or guardian to minors under 16 years. Child under 13 may hunt without license when accompanied by licensed parent or guardian. Resident owner of farm lands and minor children may hunt during open season on own land without license. Guide: Nonresident, \$20; resident, \$1. Issued by commissioner.	
Bag limits and possession: Two deer a season; 5 hares, 5 quail a day; 5 ruffed grouse a day, 25 a season; 5 woodcock a day, 25 a season; 20 ducks, 8 geese, 8 brant, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 50 sora, and 25 in all of other rails, coots, and gallinules a day. Deer may be possessed for a reasonable time after close of open season.	

^a Nevada: County commissioners may shorten open seasons on game and with approval of State warden may fix seasons on valley quail and may shorten season on doves.

^a New Hampshire: Governor and council may suspend open season in time of excessive drought.

Sale: Sale of all migratory birds prohibited. Sale for food purposes prohibited of the dead bodies of birds belonging to a family any species or subspecies of which is native to and protected by the State; provided, deer, hares, and rabbits may be sold during the open season.

Export: Export of all protected game prohibited; provided, game (except ruffed grouse) imported from without the United States or raised in private preserves, when tagged and marked to show kind and number, name and address of consignor and consignee, and initial point of billing and destination, may be exported unaccompanied by the owner, but not more than two days' limit of migratory birds may be exported in any one calendar week. Game for propagation, the head, hide, feet, or fur of game quadrupeds, and the plumage or skin of game birds (except migratory birds) legally taken and possessed may be transported without being marked.⁴³ Nonresident may take with him out of the State, under his hunting license and permit, one day's limit of game birds when properly marked and tagged and two deer under license tags.

NEW JERSEY.

Open seasons:

Dates inclusive.

Deer ⁴⁴ (male, with horns visible above the hair)-----	Dec. 16-Dec. 25.
Raccoon-----	Oct. 1-Dec. 15.
Rabbit, squirrel, quail, ruffed grouse (partridge), prairie chicken, Hungarian partridge, English or ringneck pheasant cocks (see exception), wild turkey-----	Nov. 16-Dec. 15.
<i>Exception:</i> Ringneck pheasant in and within 1 mile of Chmaminson, Chester, and Belran Townships, in Burlington County, and Pensauken Township, in Camden County-----	
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule-----	No open season.
Black-bellied and golden plovers, yellowlegs-----	Oct. 16-Jan. 31.
Woodcock-----	Aug. 16-Nov. 30.
Rail (marsh hen), other than coot and gallinule-----	Oct. 1-Nov. 30.
Reedbird-----	Sept. 1-Nov. 30.
	Sept. 1-Oct. 30. ⁴⁵

No open season: Does and fawns, English or ringneck pheasant hens, doves, swans, wood ducks, elder ducks, auks, bitterns, little brown, sandhill, and whooping cranes, fulmars, gannet, grebes, gulliemots, gulls, herons, jaegers, loons, murre, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: Game and fish, \$10.15; fish, \$2.15. Resident male citizen above age of 14: Game and fish, \$1.15. When applied for by parent or legal guardian, in discretion of commission, license may be granted to children between ages 10 and 14 to hunt when accompanied by adult holder of a general license: fee, \$1; issued only by commission. All other licenses issued by county, city, or town clerk, salaried warden, or registrar of licenses.

Alien prohibited from hunting or owning shotgun or rifle unless he is the owner of real property in New Jersey to the value of \$2,000 above all incumbrances, in which case he may secure nonresident license.

Bag limits and possession: One deer a season; 10 rabbits, 10 quail, 3 ruffed grouse, 3 English or ringneck pheasant cocks, 3 Hungarian partridges, 6 woodcock, 25 ducks, 8 geese, 8 brant, 25 snipe, 15 in all of plovers and yellowlegs, 50 reedbirds, 50 sora and 25 in all of other rails (marsh hens), coot, and gallinules, a day or in possession. Possession of all game (except deer) permitted during the first 10 days of close season.

Sale: The sale of deer, squirrel, reedbirds, and all game birds is prohibited; rabbits may be sold during open season and 15 days thereafter; Belgian hares and jack rabbits legally killed in another State may be imported and sold at any time; the unplucked carcasses of Canada geese and mallard, wood, and black ducks (when raised in captivity under Federal permits), deer, squirrel, quail, ruffed grouse, and pheasants raised on licensed game preserves and properly tagged, and the unplucked carcasses of Scotch grouse, European black grouse, European black plover, red-legged partridge, and Egyptian quail coming from a foreign country, which are properly tagged by State authorities, may be sold at any time for food purposes.

⁴³ New Hampshire: See sec. 243, Lacey Act, p. 62.

⁴⁴ New Jersey: Wild deer may be taken only with shotgun not smaller than 12 gauge, which may not be loaded with a bullet or other missile larger than buckshot. Killing of a deer must be reported to commissioners or county warden within 48 hours. Landowner or his authorized agent may kill deer on his own cultivated land at any time; carcass of deer so killed is the property of the commission, and such killing must be reported within 48 hours.

⁴⁵ See order of the Secretary of Agriculture, p. 76.

Export: Export of all protected game (except deer) prohibited, except a nonresident licensee, in one day, may carry from State the daily bag limit of game, if open to view, but not more than two days' limit of game may be exported in one calendar week.

Miscellaneous: Unlawful to use shotgun or rifle holding more than 2 cartridges or that may be fired more than twice without reloading.

NEW MEXICO.

Open seasons: *Dates inclusive.*

Deer (with horns at least 6 inches in length), squirrel (tassel-eared gray), wild turkey-----Oct. 20-Nov. 5.

Quail (except bobwhite)-----Nov. 1-Dec. 31.

Turtle dove and white-winged dove, black-bellied and golden plovers, yellowlegs-----Sept. 1-Dec. 15.

Duck (goose, brant, Wilson snipe, coot, gallinule)-----Oct. 16-Jan. 31.

Rails, other than coot and gallinule-----Sept. 1-Nov. 30.

No open season: Does, Sonoran deer, elk, sheep, goat, antelope, buffalo, bobwhite quail, pheasant, ptarmigan, prairie chicken, sage hen, grouse, swans, wood duck, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, loons, band-tailed pigeons, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: Big game, bird, and fish, \$35.25; big game and bird, \$30.25; big game, \$25.25; bird, \$10.25; fish, \$5. Resident: Big game, bird and fish, \$2.50; big game and bird, \$2.25; big game, \$1.50; bird, \$1.25; fish, \$1; guide, \$5.25; duplicate, \$1. Issued by county clerks and deputies designated by State warden.

Bag limits and possession: One deer a season; 3 wild turkeys, 20 quail, 25 doves a day or in possession; 25 ducks, 8 geese, 8 brant, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 50 sora and 25 in all of other rails, coots, and gallinules a day. Possession permitted during open season and first 5 days of close season. Under permit, game, except migratory birds, may be held in storage for first 90 days of close season; migratory birds may be so held for a period of 10 days.

Sale: Sale of all protected game taken in the State prohibited; provided, game (except migratory birds) imported into State by hotel, restaurant, café, boarding-house keeper, or dealer may be sold under a permit good for not more than 30 days.

Export: Export of all game taken in the State prohibited, except under permit, fee \$1.25 (1 deer and 3 turkeys); and \$1.25 for bag limit of other birds and fish; holder of hunting license, under permit from warden, may export game or birds for scientific or propagating purposes.

NEW YORK.

Open seasons: ⁴⁶ *Dates inclusive.*

Deer (with horns not less than 3 inches long) in Adirondack region ⁴⁷-----Oct. 15-Nov. 15.

Deer (with horns not less than 3 inches long), in Delaware, Orange, Rensselaer, ⁴⁸ Sullivan, and Ulster Counties-----Nov. 1-Nov. 15.

On own land in Dutchess County ⁴⁸-----Nov. 1-Nov. 15.

Varying hare, rabbit ⁴⁶-----Oct. 1-Mar. 1.

Squirrel, black, gray, or fox-----Oct. 1-Nov. 15.⁴⁹

Grouse, partridge ⁴⁶-----Oct. 15-Nov. 15.

Pheasant, male only ⁴⁶ (four days only)-----Oct. 21 and 28.
Nov. 6 and 13.

Waterfowl, Wilson snipe or jacksnipe, coot, gallinule-----Sept. 16-Dec. 31.

Black-bellied and golden plovers, yellowlegs-----Aug. 16-Nov. 30.

Woodcock-----Oct. 1-Nov. 30.

Rails, other than coot and gallinule-----Sept. 1-Nov. 30.

⁴⁶ *New York:* Commission may shorten open seasons on game. Open season on upland game fixed or closed by order of commission as follows: *Cottontail rabbit* in Richmond County, October 1-November 14 and January 1-31.

⁴⁷ The Adirondack region comprises the counties of Clinton, Essex, Franklin, Fulton, Hamilton, Herkimer, Jefferson, Lewis, Oneida, Oswego, Saratoga, St. Lawrence, Warren, and Washington.

⁴⁸ In Dutchess and Rensselaer Counties, deer may only be taken with shotgun loaded with slugs or shot not smaller than buckshot.

⁴⁹ May only be taken in corporate limits of city or village under permit of commission.

No open season: Elk, moose, caribou, antelope, fawns; Hungarian or European gray-legged partridge; dove; quail (1925); swans, wood duck, elder ducks, auks, bitterns, sandhill and whooping cranes, fulmars, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murreas, petrels, puffins, shearwaters, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses:⁵⁰ Nonresident or alien, \$10.50; resident, \$1.10. Issued by county, city, and town clerks. Owners, members of immediate families, and tenants actually occupying cultivated farm land may hunt thereon without license during open season. Licensee required to wear button.

Bag limits: One deer, 24 woodcock, 10 grouse, 3 male introduced pheasants a season; 6 varying hares or rabbits, 5 squirrels, 6 woodcock, 2 grouse, 25 ducks, 8 geese, 8 brant, 25 in all of rails, coots, mud hens and gallinules, 15 in all of plovers and yellowlegs, 25 Wilson snipe or jacksnipe a day.

Possession: Deer, grouse, and pheasant during open season and 5 days thereafter; migratory game birds during open season and 10 days thereafter. Deer properly tagged may be possessed under \$1 permit to February 1.

Sale: Sale of all game birds prohibited; provided, varying hares and rabbits legally taken in State during open season (from without State at any time), and unplucked carcasses of pheasants, Scotch grouse, European gray-legged partridge, European black game, red-legged partridge, and Egyptian quail, and carcasses of European red deer, fallow deer, roebuck, and reindeer imported from without the United States may be sold under license at any time when duly tagged.

Licensed breeders in States having laws similar to the game-breeding law of New York may import, under \$5 license and cost of inspection, domesticated American elk, white-tailed deer, European red deer, fallow deer, roebuck, pheasants, Canada and Hutchins geese, and mallard and black ducks, when duly tagged, for sale under regulations of conservation commission.

Head, hide, and feet of quadrupeds legally taken and possessed may be sold at any time.

Exports: Export of game and birds prohibited, except any person may export 1 deer, except by parcel post, and one day's bag limit of other game in one day during open season by means other than parcel post. The taker may export in one day by common carrier, except parcel post, one day's limit when accompanied by permit which shall show contents of package. Head, hide, and feet of animals and plumage or skin of game birds legally taken may be exported at any time.

Miscellaneous: Hunting prohibited on lands supplying any municipality with water or on public highways, except public highways within forest preserve counties.

NEW YORK—Long Island.

Open seasons:	Dates inclusive.
Squirrel (black, gray, fox), quail, ruffed grouse, pheasant (male only)-----	Nov. 1-Dec. 31.
Varying hare-----	Oct. 1-Mar. 1.
Cottontail rabbit-----	{ Oct. 1-Oct. 31. Jan. 1-Mar. 1.
Waterfowl, Wilson snipe or jacksnipe, coot, mudhen, gallinule-----	Oct. 16-Jan. 31.
Black-bellied and golden plovers, yellowlegs-----	Aug. 16-Nov. 30.
Woodcock-----	Oct. 1-Nov. 30.
Rail, other than coot and gallinule-----	Sept. 1-Nov. 30.

No open season: Deer, dove, swans, wood duck, elder ducks, auks, bitterns, sandhill and whooping cranes, fulmars, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murreas, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Bag limits and possession: Forty quail, 10 ruffed grouse, 30 male pheasants a season; 6 quail, 2 ruffed grouse, 4 male pheasants a day. For other bag limits see New York.

Hunting licenses, sale, export, miscellaneous: (See New York.)

⁵⁰ New York: Nonresident fishing license fee, \$2.50. Issued by county, city, and town clerks. Not required of persons under 16 years of age or in international boundary waters if residents require no license in that part of those waters not within jurisdiction of State.

NORTH CAROLINA.⁵¹Open seasons: ⁵¹

Dates inclusive.

Dove	Oct. 16-Jan. 31.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule	Nov. 1-Jan. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1-Dec. 15.
Woodcock	Nov. 1-Dec. 31.
Rail, other than coot and gallinule	Sept. 1-Nov. 30.
Reedbird (ricebird)	Aug. 16-Nov. 15. ⁵²

No open season: Swans, wood duck, auks, bitterns, gannet, grebes, gulls, herons, jaegers, loons, murres, petrels, shearwaters, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses.⁵¹

Bag limits and possession: Twenty-five doves, 25 ducks, 8 geese, 8 brant, 6 woodcock, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 50 sora and 25 in all of other rails, coots, and gallinules a day. Possession of migratory birds permitted during first 10 days of close season.

Sale: Sale of reedbirds (ricebirds) and all migratory birds prohibited.

Export: The export is prohibited of quail, partridge, pheasant, grouse, wild turkey, snipe shore or beach birds, woodcock, taken in State.

Exceptions: Nonresident may take out of State under his hunting license 50 quail (partridges), 12 grouse, 2 turkeys, and 50 in all of Wilson snipe, plovers, and yellowlegs in a season, but not more than two days' limit of migratory birds shall be exported in any one calendar week. Export permitted under permit of Audubon Society of ruffed grouse and wild turkey for propagation.

NORTH DAKOTA.

Open seasons:

Dates inclusive.

Prairie chicken (pinnated grouse), sharp-tailed (white-breasted) grouse, black-bellied and golden plovers, yellowlegs, Wilson snipe	Sept. 16-Oct. 16.
Ruffed grouse in Bottineau, Cavalier, Pembina, and Roullette Counties only	Oct. 1-Oct. 10.
Duck, goose, brant	Sept. 16-Dec. 1.
Coot, gallinule	Sept. 16-Dec. 31.
Woodcock	Oct. 1-Oct. 16.
Rail, other than coot and gallinule	Sept. 1-Nov. 30.

No open season: Deer (1921); elk, moose, antelope, quail, ruffed grouse (except as above), English and Chinese ringneck pheasants, Hungarian partridge, dove, swans, wood duck, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, loons, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, \$25; resident, \$1.50. Issued by commissioners, deputy, or county auditor. Aliens not permitted to hunt. Person or member of family permanently residing with him may hunt without license during open season on own lands or lands cultivated by him. Resident license may be issued to settler. No person permitted to enter cultivated or posted lands without consent of owner.

Bag limits and possession: Five prairie chickens, sharp-tailed grouse, plovers, each or all combined a day, 10 each or all in possession at one time, 15 in all of plovers and yellowlegs, but not more than 5 plovers a day; 5 ruffed grouse a day, 15 in possession; 15 snipe, woodcock, rails, ducks, geese, each or all combined a day, but not more than 8 geese, 8 brant, or 6 woodcock, 30 in possession; 25 in all of rails, coots, and gallinules a day. Resident licensee under permit may retain not to exceed 20 pinnated or sharp-tailed grouse, 30 waterfowl, but not more than 50 birds in all during first 5 days of close season.

Sale: Sale of all protected game prohibited, except hides, heads, and trophies of big game lawfully taken may be sold at any time.

⁵¹ *North Carolina:* Only the Federal seasons and other restrictions on migratory birds are given. County seasons and provisions relating to licenses, bag limits, sale, and export are too numerous to be included. Full information regarding laws applicable to counties under jurisdiction of Audubon Society may be had on application to the secretary, Audubon Society, Raleigh, N. C. The county laws should be consulted, as in some instances they prohibit the hunting of migratory game birds during part of the periods mentioned in the table. Wood duck, swans, robins, larks, and certain other migratory birds may not be killed at any time. (See Migratory Bird Regulations, pp. 64-75; and order of the Secretary of Agriculture, regarding reedbirds, p. 76.)

Export: Export of all protected game prohibited, except nonresident licensee may carry with him from State under license tag prairie chickens and sharp-tailed grouse not exceeding 20 in all, and ducks, geese, and brant not exceeding 30 in all, or a total of 50 of all birds combined, if open to view and labeled with his name and address and number of his license. Not more than 2 days' limit of migratory birds shall be exported in any one calendar week. Board may grant permits for the export of live game.

OHIO.

Open seasons:	Dates inclusive.
Hare, rabbit-----	Nov. 15-Jan. 1. ²²
Squirrel-----	Sept. 15-Oct. 20.
Ruffed grouse, cock pheasant (introduced), Hungarian partridge-----	Nov. 15-Nov. 25.
Duck, goose, brant, Wilson snipe, black-bellied and golden plovers, yellowlegs, coot, gallinule-----	Sept. 16-Dec. 31.
Woodcock-----	Oct. 1-Nov. 30.
Rail, other than coot and gallinule-----	Nov. 1-Nov. 30.

No open season: Deer, quail, dove, swans, wood duck, eider ducks, bitterns, sandhill and whooping cranes, grebes, gulls, herons, jagers, loons, murrees, petrels, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident citizen: General, \$15.25; fish, \$2. Resident citizen, \$1.25. Issued by county and township clerks. Person under 16 when hunting must be accompanied by adult. Owners, tenants, or their children may hunt without license during open season on own or leased lands. Written permission required on land of another.

Bag limits and possession: Five squirrels and 10 rabbits a day or in possession; 3 ruffed grouse, 3 cock pheasants, and 6 Hungarian partridge, 15 in all of plovers and yellowlegs, 15 Wilson snipe, 6 woodcock, 8 geese, 25 ducks; 35 sora and 25 in all of other rails, coots, and gallinules a day. Waterfowl, coots, and gallinules may be possessed during first 10 days of close season.

Sale: Sale prohibited of all protected game (except hare or rabbit during open season).

Export: Export prohibited of all protected game (except rabbit) taken in State; provided, a nonresident may take with him from State under his hunting license 25 pieces of game. But not more than two days' limit of migratory birds may be exported by one person in any one calendar week. Packages containing game or fur-bearing animals or parts thereof must be marked to show contents, initial point of billing, and names and addresses of consignor and consignee.

OKLAHOMA.

Open seasons: ²³	Dates inclusive.
Quail-----	Dec. 1-Dec. 31.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule-----	Oct. 16-Jan. 31.
Black-bellied and golden plovers, yellowlegs, dove-----	Sept. 1-Dec. 15.
Woodcock-----	Nov. 1-Dec. 31.
Rail, other than coot and gallinule-----	Sept. 1-Nov. 30.

No open season: Deer (1922), antelope, prairie chicken, imported pheasant, wild turkey, swans, wood duck, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, loons, band-tailed pigeons, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, \$15; alien, \$25; resident citizen, \$1.25. Issued by warden, deputy, or county clerk. A person may hunt without license during open season on own or leased premises actually occupied by him. Application of person under 14 must be approved in writing by parent or guardian. Unlawful to shoot on or across highway or railroad right of way. Unlawful to hunt on lands of another without owner's permission.

Bag limits and possession: Fifteen quail, plover, snipe, or ducks a day, 100 a season; 15 yellowlegs, but not more than 15 in all of plovers and yellowlegs a day; 8 geese, 8 brant a day, but not more than 10 in all a day; 50 sora and 25 in all of other rails, coots, and gallinules and 6 woodcock a day. Possession of migratory birds permitted during first 10 days of close season.

²² *Ohio:* Landowners, tenants, and employees may take hares or rabbits, when doing substantial damage to crops, trees, or shrubbery, at any time except on Sunday.

²³ *Oklahoma:* Bear in Blaine, Caddo, Comanche, Kiowa, and Major Counties, no open season; in rest of State, unprotected.

Sale: Sale prohibited of all protected game, except that heads, hides, and horns of big game lawfully killed may be sold.

Export: Export prohibited of all protected game, but nonresident licensee may carry to his home two days' bag limit of game birds if license permit is attached.

OREGON.⁵⁴

Open seasons:

District No. 1,⁵⁵ west of Cascades:

	Dates inclusive.
Deer (male, with horns)-----	Sept. 1-Oct. 31.
Silver-gray squirrel, dove-----	Sept. 1-Oct. 31.
Quail in Coos, Curry, Jackson, and Josephine Counties only-----	Oct. 1-Oct. 31.
Grouse, male Chinese pheasant (see exceptions)-----	Oct. 1-Oct. 31.

Exceptions: Grouse and male Chinese pheasant

in Jackson County-----Oct. 1-Oct. 10.

Chinese pheasants in Coos, Curry, and

Josephine Counties-----No open season.

Sooty or blue grouse in Douglas County-----Sept. 1-Sept. 30.

Duck, goose, brant, Wilson snipe, coot, black-bellied and golden plovers, yellowlegs (see exception)-----Oct. 16-Jan. 15.

Exception: In Clatsop, Columbia, Multnomah,

and Tillamook Counties-----Oct. 1-Dec. 31.

Rail, other than coot (see exception)-----Oct. 16-Nov. 30.

Exception: In Clatsop, Columbia, Multnomah,

and Tillamook Counties-----Sept. 16-Nov. 30.

District No. 2,⁵⁶ east of Cascades:

Deer (male, with horns) (see exception)-----Sept. 1-Oct. 31.

Exception: In Union and Wallowa Counties-----Sept. 10-Nov. 10.

Quail in Klamath County only-----Oct. 1-Oct. 10.

Ruffed grouse, native pheasant, blue or sooty grouse (see exception)-----Aug. 15-Oct. 31.

Exception: In Union and Wallowa Counties-----Aug. 1-Nov. 10.

Prairie chicken in Sherman and Wasco Counties only-----Oct. 1-Oct. 15.

Sage hen-----July 15-Aug. 31.

Chinese pheasants in Baker, Grant, Malheur,

Umatilla, and Union Counties-----Oct. 3-Oct. 10.

In Hood River and Wasco Counties-----Oct. 25-Nov. 1.

In remainder of district-----No open season.

Dove-----Sept. 1-Oct. 31.

Duck, goose,⁵⁷ Wilson snipe or jacksnipe, black-bellied and golden plovers, yellowlegs, coot, gallinule-----Oct. 1-Dec. 31.

Rail, other than coot-----Oct. 1-Nov. 30.

No open season: Doe and spotted fawn, moose, elk, antelope, sheep, goat, Hungarian partridge, bobwhite, prairie chicken, Franklin grouse, foolhen, wild turkey, silver-gray squirrel, quail, and introduced pheasants (except as above); swans, wood duck, auklets, auks, bitterns, little brown and sandhill cranes, fulmars, grebes, gulleimots, gulls, herons, jaegers, loons, murrees, petrels, band-tailed pigeon, puffins, shearwaters, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: Game, \$10; alien, gun license, \$25 (in addition to hunting and angling license); issued by commissioners. Resident, game and fish, \$3; game, \$1.50. Angling, resident or nonresident,⁵⁸ \$1.50 (not required of female); issued by county clerks and duly appointed agents throughout the State. Licenses not issued to persons under 14 years of age, who may hunt with gun on own premises or those of parent, relatives, or guardian only. Unlawful to hunt on inclosed or

⁵⁴ Oregon: Governor may suspend open season in time of drought.

⁵⁵ District No. 1, west of Cascades, includes Benton, Clackamas, Clatsop, Columbia, Coos, Curry, Douglas, Jackson, Josephine, Lane, Lincoln, Linn, Marion, Multnomah, Polk, Tillamook, Washington, and Yamhill Counties. District No. 2 east of Cascades, includes all other counties in the State.

⁵⁶ District No. 2, east of Cascades, includes all counties not in District No. 1 (see footnote 55).

⁵⁷ Unlawful to kill geese at any time on islands or sand bars in the Columbia east of the Cascades or on Deschutes and John Day Rivers south to junction with White River and Thirtymile Creek, respectively.

⁵⁸ Fee required of nonresident angler equal to that required of nonresident in his State of residence.

Hunting and fishing licenses—Continued.

occupied land of another without permission of owner. Unlawful to shoot from highways or railroad rights of way. Licenses, good for life, issued free of charge by county clerks to pioneers of State who arrived prior to 1860, and veterans of Indian and Civil Wars upon proof of service.

Bag limits and possession: Two deer a season; 5 silver-gray squirrels and 10 quail in 7 consecutive days; 5 in all of sage hens and prairie chickens a day, 10 in 7 consecutive days; 5 in all of ruffed grouse, pheasants, and sooty or blue grouse a day, 10 in 7 consecutive days; 5 Chinese pheasants a day, 10 in 7 consecutive days, but in district 1 a bag of 10 shall not include more than 3 hens and in district 2 more than 2 hens; 10 doves a day, 20 in 7 consecutive days; 25 ducks, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 25 in all of rails, coots, and gallinules a day, but not more than 25 in all in one day nor more than 30 in all in 7 consecutive days; 8 geese a day, 30 in 7 consecutive days. Migratory game birds properly tagged may be possessed during first 10 days of close season; other game, when properly tagged, during close season.

Sale: Sale of all protected game prohibited. Game birds (except migratory birds) and animals imported from without the United States, when duly tagged, may be sold. Tag fee, 5 cents each. Commissioners may make regulations permitting the sale of game, except migratory birds.

Export: Export of all protected game prohibited.

PENNSYLVANIA.**Open seasons:**⁵⁰*Dates inclusive.*

Deer—male with horns 2 inches above the hair	Dec. 1—Dec. 15.
Bear	Oct. 15—Dec. 15.
Raccoon	Sept. 1—Dec. 31.
Hare, rabbit	Nov. 1—Dec. 15.
Squirrels, quail, ruffed grouse, ringneck pheasant, Hungarian partridge	Oct. 20—Nov. 30.
Wild turkey	Nov. 15—Nov. 30.
Duck, goose, brant	Sept. 18—Dec. 31.
Black-bellied and golden plovers, yellowlegs, coot (mudhen), gallinule, Wilson snipe or jacksnipe	Sept. 16—Nov. 30.
Woodcock	Oct. 1—Nov. 30.
Rail	Sept. 1—Nov. 30.
Reedbird	Sept. 1—Oct. 30. ⁵⁰
Blackbird	Aug. 1—Nov. 30.

No open season: Elk (1921), doe, fawn, dove, swans, wood duck, elder ducks, auks, bitterns, little brown and sandhill cranes, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, \$10. Issued by commission or county treasurer. Resident, \$1 from county treasurer, \$1.15 from justice of the peace. Licenses not issued to minor under 14 years of age, and minor between 14 and 16 must furnish written consent of parent or guardian. Licensee required to wear tag displayed and to carry license on person.

Resident citizen and members of family residing upon and cultivating land in State as either owner or lessee may hunt on such land and, with consent of owner, on adjoining land without a license.

Aliens not permitted to hunt or be possessed of firearms.

Bag limits and possession: One deer (6 to party camping or hunting together), 1 bear (3 to party camping or hunting together), 40 rabbits, 15 hares, 20 squirrels, 1 turkey, 25 quail (Virginia partridge), 24 ruffed grouse, 10 ringneck pheasants, 10 Hungarian partridge, 20 woodcock a season. Ten rabbits, 3 hares, 6 squirrels, 8 quail (Virginia partridge), 4 ruffed grouse, 4 ringneck pheasants, 4 Hungarian partridge, 6 woodcock, 25 ducks, 8 geese, 8 brant, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 50 sora, 25 in all of other rails, coots, and gallinules a day. Possession of migratory birds permitted during first 10 days of close season; other game during first 30 days thereof.

Sale: Sale prohibited of wild deer, elk, squirrel, rabbit or hare, wild ringneck pheasant, Hungarian partridge taken in the State; and of quail, ruffed grouse (pheasant), wild turkey, reedbirds, and all other migratory birds (wherever taken); provided, bears, raccoons, and blackbirds may be sold at any time.

Export: The export is prohibited of all protected game; provided, a nonresident licensee may take out with him on the same conveyance one day's limit of game. Small game

⁵⁰ *Pennsylvania:* Seasons may be closed on petition to commission.

⁵⁰ See order of Secretary of Agriculture, p. 76.

Export—Continued.

to be carried upon the person in hunting coat or game bag, or as hand baggage, without cover. Large game may be shipped by express when plainly marked. Shipment by parcel post prohibited.

Miscellaneous: Use of automatic guns prohibited.

RHODE ISLAND.**Open seasons:***Dates inclusive.*

Gray squirrel, hare, rabbit, quail or bobwhite, ruffed grouse or partridge, pheasant	Nov. 1–Dec. 31.
Duck, goose, brant, coot, gallinule	Oct. 1–Jan. 15.
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 30.
Wilson snipe	Oct. 1–Nov. 30.
Woodcock	Nov. 1–Nov. 30.
Rails, other than coot and gallinule	Sept. 1–Nov. 30.

No open season: Deer; ^a dove; Hungarian partridge (Nov. 1, 1920); swans, wood duck, elder ducks, auks, bitterns, little brown and sandhill cranes, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murre, petrels, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, \$10.15; alien, \$15.15; resident, \$1.15. Issued by city and town clerks.

Not required of resident or his immediate family to hunt on own or leased agricultural lands on which actually domiciled; nonresident owning real estate valued at not less than \$500, and nonresident member of club incorporated for hunting or fishing purposes prior to Jan. 1, 1909, which owns real estate assessed for taxation at value of not less than \$1,000, may procure license at a fee of \$1.15; licenses not issued to minors under 15 years of age. Consent of owner required for hunting on land of another from Oct. 15–Dec. 15.

Bag limits and possession: Fifteen ducks, 8 geese, 8 brant, 6 woodcock, 15 in all of plovers and yellowlegs, 15 Wilson snipe, 15 in all of rails, coots, and gallinules a day, but not more than 15 game birds of all kinds in possession at one time. Possession of waterfowl, coots, gallinules, and woodcock permitted during first 10 days of close season.

Sale: Sale of all protected game birds prohibited.

Export: Export prohibited of all game; provided, a nonresident licensee may take out under his license 10 wild fowl or birds in one calendar year, if carried open to view.

SOUTH CAROLINA.**Open seasons:***Dates inclusive.*

Deer (male)	Sept. 1–Jan. 1.
Bear, rabbit, squirrel	Oct. 1–Mar. 15.
Quail (partridge), wild turkey	Nov. 25–Mar. 1. ^a
Dove	Oct. 16–Jan. 31.
Duck, goose, brant, coot, gallinule, Wilson snipe	Nov. 1–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Dec. 15.
Rail, other than coot and gallinule	Sept. 1–Nov. 30.
Woodcock	Nov. 1–Dec. 31.
Reedbird	Aug. 16–Nov. 15. ^a
Blackbird	Oct. 1–Mar. 1.

No open season: Does; ruffed grouse (pheasant) (1925); swans, wood duck, auks, bitterns, little brown, sandhill, and whooping cranes, gannet, grebes, gulls, herons, jaegers, loons, murre, petrels, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: Game, \$15.25; fish, \$3.25. Issued by county clerk. Resident: Game, State, \$3.10; county of residence, \$1.10. Issued by county clerk or game warden.

No license required of resident owners, tenants, their children, or, under written permission, their employees, to hunt during open season on own lands.

Consent of owner or manager required to hunt on land of another.

^a *Rhode Island:* Deer injuring crops may be killed at any time by the owner or occupant of the premises under written permit from Secretary of State.

^a *South Carolina:* Season opens on Thanksgiving Day.

^a See order of the Secretary of Agriculture, p. 76.

Bag limits: Five deer, 20 wild turkeys a season; 15 squirrels, 15 quail (partridge), 25 doves, 2 turkeys, 25 ducks, 8 geese, 8 brant, 6 woodcock, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 50 sora, and 25 in all of other rails, coots, and gallinules a day. Possession of migratory birds permitted during first 10 days of close season.

Sale: Sale prohibited of deer, quail (partridge), dove, turkey, reedbirds, and all other migratory birds.

Export: Export prohibited of all protected game taken in State; provided, a nonresident licensee may export 2 deer, 50 quail, and 4 turkeys a season, and two days' limit of migratory birds a calendar week, if game is not for sale and packages are marked to show contents.

SOUTH DAKOTA.

Open seasons:	Dates inclusive.
Deer.....	Nov. 1–Nov. 30.
Partridge, grouse, prairie chicken, black-bellied and golden plovers, yellowlegs.....	Sept. 16–Oct. 15.
Duck, goose, brant, coot, gallinule, Wilson snipe.....	Sept. 16–Dec. 31.
Woodcock.....	Oct. 1–Nov. 30.
Rail, other than coot and gallinule.....	Sept. 16–Nov. 30.

No open season: Elk, antelope, mountain sheep, quail, dove, pheasant, upland plover, swans, wood duck, elder ducks, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, loons, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or Jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident: Big game, \$25; small game, \$15; issued by game warden or county treasurer. Resident: Big game, \$5; small game, \$1; issued by county treasurer. Hunting game birds during open season on own land permitted without license. Unlawful to hunt on cultivated land of another without permission of owner.

Bag limits and possession: One deer a year; 25 ducks, geese, brant, coot, gallinules, sora, and other rails in the aggregate of all kinds (but not more than 8 geese or brant), and 5 of each other species of game birds a day; 50 in all of ducks, geese, or brant, or other aquatic fowl and snipe, and 15 in all of prairie chickens, partridge, grouse, and plover in possession. Possession permitted during open season and five days thereafter.

Sale: Sale of all protected game prohibited; provided, skins, heads, and antlers of deer lawfully killed may be sold.

Export: Export of all protected game prohibited; provided, a nonresident may export 1 deer lawfully killed under permit of State game warden and not more than 10 birds under each of the five coupons attached to his nonresident license; but not more than 50 ducks, 16 geese, 16 brant, 12 woodcock, 50 snipe, 30 in all of plovers and yellowlegs, and 50 in all of rails, coots, and gallinules may be exported by one person in any one calendar week, and if exported by common carrier, tags attached to hunting license must be affixed to each shipment.

TENNESSEE.

Open seasons:	Dates inclusive.
Deer in Bledsoe, Cumberland, Grundy, Marion, Sequatchie, and Van Buren Counties.....	Nov. 1–Dec. 10.
In rest of State.....	Unprotected.
Squirrel (see exceptions).....	June 1–Dec. 31.

Exceptions: In Bledsoe, Cannon, Cumberland, Franklin, Grundy, Lincoln, Loudon, Marion, Marshall, Sequatchie, Sumner, and Van Buren Counties, unprotected; in Dickson, June 1–Nov. 1; in Dyer, June 1–July 1 and Oct. 1–Jan. 1; in Fayette, Rutherford, June 1–Jan. 1; in Giles, Oct. 15–July 1; in Smith and Wilson, May 1–Mar. 1; in Warren, Nov. 1–Mar. 1.

Rabbit:.....Unprotected.

Quail or partridge, wild turkey (additional season for gobblers, Apr. 1–25) (see exceptions).....Nov. 15–Dec. 31.

Exceptions: Quail, in Bedford and Moore Counties, Dec. 1–Jan. 1; in Benton and Carroll, Dec. 1–Jan. 31; in Bledsoe, Cumberland, Grundy, Marion, Sequatchie, and Van Buren, Nov. 1–Feb. 1; in Bradley, Campbell, Franklin, Giles, Henry, Hickman, and Knox, Dec. 1–Feb. 1; in Cannon and White, Nov. 15–Feb. 15; in Crockett, Rutherford, and Sumner, Nov. 15–Jan. 1; in Dickson, Lawrence, and Obion, Nov. 15–Jan. 15; in Dekalb, Hawkins, and Meigs, Nov. 15–Feb. 1; in

Open seasons—Continued.

Dates inclusive.

Fayette, Nov. 22–Mar. 5; in Hardeman and Haywood, Dec. 15–Mar. 1; in Henderson, McNairy, and Weakley, Dec. 15–Feb. 15; in Monroe, Dec. 1–Jan. 15; in Lincoln, Dec. 1–Feb. 15; in Sullivan, Nov. 20–Feb. 15; in Washington, Nov. 20–Jan. 1; in Warren, Dec. 1–Mar. 1. Season closed in Grainger until 1921; in Union until 1924; Claiborne, no open season.

Wild turkey, in Bledsoe, Cumberland, Grundy, Marion, Sequatchie, and Van Buren Counties, Nov. 1–Jan. 1, and also on gobblers only, Apr. 1–May 1; in Lincoln, Nov. 1–Mar. 1; and also on gobblers only, Apr. 1–Apr. 25; in Cannon and Sullivan, unprotected.

Dove (see exceptions)-----Sept. 1–Dec. 15.

Exceptions: In Fayette, Sept. 1–Nov. 1; in Obion, Sept. 1–Sept. 15; in Sullivan, Nov. 20–Dec. 15; in Claiborne, no open season.

Duck, goose, brant, coot, mudhen, gallinule, Wilson snipe or jacksnipe-----Nov. 1–Jan. 31.

Black-bellied and golden plovers, yellowlegs-----Sept. 1–Dec. 15.

Rail, other than coot and gallinule-----Sept. 1–Nov. 30.

No open season: Grouse, ringneck, and Mongolian pheasant, woodcock, swans, wood duck, bitterns, sandhill and whooping cranes, grebes, gulls, herons, loons, terns, and all shore birds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, \$10 (may hunt on own land without license). Resident: State, \$2; county, \$1 (county licensee may obtain State license for \$1). Issued by county clerks. County license not required of residents in Cannon, Hardin, Houston, and Jackson Counties; of residents to hunt squirrels in Dyer, Lincoln, Smith, Wayne, and Wilson Counties; or of residents to hunt squirrels in Clay, Fentress, Jackson, Macon, Pickett, and Overton Counties when hunting on uninclosed or with permission of owner on inclosed lands.

Owners and tenants may hunt without license on land on which they reside. Unlawful to hunt on tillable or inclosed lands of another without written permission.

Reelfoot Lake: Special license, fee \$2, in addition to State license, required of residents to hunt thereon. Resident, fish, \$1. Nonresident, fish, \$2. Guide or pusher, \$1.

Bag limits and possession: Twenty game birds and animals a day, but not more than 8 geese, 8 brant, 15 in all of plovers and yellowlegs a day; in Lauderdale County, 6 squirrels, 12 quail, and 2 turkeys a day or in possession.

Sale: Sale prohibited of migratory birds and of all other protected birds killed in State.

Export: Export of all protected game prohibited; provided, nonresident licensee may take out of State, if carried openly, game birds legally killed by him (except 25 birds only may be exported from Reelfoot Lake), but not more than 50 ducks, 16 geese, 16 brant, 10 Wilson snipe, 30 in all of plovers and yellowlegs, 50 in all of rails, coots, and gallinules, and 50 doves may be exported by one person in any one calendar week.

TEXAS.

Open seasons:

Dates inclusive.

Deer (male)-----Nov. 1–Dec. 31.

Quail or partridge, chachalaca or Mexican pheasant-----Dec. 1–Jan. 31.

Wild turkey gobblers-----Mar. 1–Apr. 30.

Doves-----Sept. 1–Dec. 15.

Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule-----Oct. 16–Jan. 31.

Black-bellied and golden plovers, yellowlegs-----Oct. 16–Dec. 15.

Rail, other than coot and gallinule-----Oct. 16–Nov. 30.

No open season: Antelope, does, sheep (1924); turkey hens, robins; prairie chicken, pin-nated grouse, pheasant (except chachalaca), woodcock (1924); swans, wood duck, bitterns, little brown, sandhill, and whooping cranes, gannet, grebes, gulls, herons, jaegers, loons, petrels, band-tailed pigeons, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting licenses: Nonresident or alien, \$15; issued by game, fish, and oyster commissioner, deputies, and county clerks. Resident, \$2, not required in county of residence; issued by commissioner, deputies, and county clerks.

Bag limits and possession: Three deer, 3 turkey gobblers a season; 15 in all of quail and chachalaca; 15 doves; 25 in all of waterfowl and shorebirds, but not more than 8 geese, 8 brant, or 15 plovers and yellowlegs; 50 sora and 25 in all of other rails, coots, and gallinules a day. Possession of all game permitted during open season and 10 days thereafter.

Sale: Sale prohibited of all protected game.

Export: Export prohibited of all game, except nonresident licensee may ship game to his home for own use under affidavit that it was lawfully killed and will not be bartered or sold; provided, that not more than two days' limit of migratory birds may be exported in any one calendar week. Game may be shipped to taxidermist for mounting under affidavit that shipper killed the specimen and that it is not being preserved for sale.

UTAH.

Open seasons: ⁶⁴	Dates inclusive.
Deer (buck, with horns) ⁶⁵ -----	Oct. 15-Oct. 25.
Dove-----	Sept. 1-Sept. 30.
Duck, goose, coot, gallinule (see exceptions)-----	Oct. 1-Dec. 31.

Exceptions: Waterfowl, in Kane, San Juan,

and Washington Counties-----Oct. 1-Jan. 15.

Duck in Fish Lake Game Preserve-----Oct. 1-Nov. 30.

Rail, other than coot and gallinule-----Sept. 1-Nov. 30.

No open season: Does, fawns, elk, antelope, sheep, quail, partridge, prairie chicken, blue grouse, sage hens, pheasants, swans, wood duck, bitterns, sandhill crane, grebes, gulls, herons, loons, band-tailed pigeon, terns, and all shorebirds.

Hunting and fishing licenses: Any male citizen, for game and fish, 12 to 16 years, \$1; 16 and over, \$2. Females over 18, \$1. Aliens prohibited from hunting or fishing in State. Residents under 12 not required to secure license. Issued by State fish and game commissioner or deputy, county clerk, or deputy or authorized agent.

Bag limits: One deer a season (resident citizen only); 25 doves, 25 in all of ducks and geese, but not more than 8 geese a day; 50 sora and 25 in all of other rails, coot, and gallinules a day.

Sale: Sale of all protected game prohibited.

Export: Export of all game prohibited; provided, nonresident licensee may ship out 25 ducks in any one calendar week after they have been examined by the commissioner or one of his deputies and a permit issued therefor.

VERMONT.

Open seasons:	Dates inclusive.
Deer (other than spotted fawn) ⁶⁶ -----	Dec. 6-Dec. 11.
Hare, rabbit-----	Sept. 15-Feb. 28.
Gray squirrel, quail-----	Sept. 15-Nov. 30.
Duck, goose, brant, coot, gallinule-----	Sept. 16-Dec. 31.
Black-bellied and golden plovers, yellowlegs, English or Wilson snipe (Jacksnipe)-----	Sept. 16-Nov. 30.
Woodcock-----	Oct. 1-Nov. 30.

No open season: Elk (1923), moose, caribou, fawns, dove, rail; pheasants, European partridge (1932); ruffed grouse and partridge (1921); swans, wood duck, auks, bitterns, sandhill and whooping cranes, grebes, gulls, herons, jaegers, loons, murrets, petrels, terns, and all shore birds (except woodcock, Wilson snipe or Jacksnipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: Game and fish, \$10.50; owner of real estate in State to value of \$1,000, \$1; fish, \$2. Resident: Game and fish, \$1; game, 60 cents; fish, 60 cents. Issued by town clerks.

Hunting licenses not issued to persons under 16 without written consent of parent or guardian. Owners of farm lands and their resident minor children or tenants may hunt without a license during open season on own lands. Fishing licenses not required of persons under 16 or of women.

Bag limits and possession: One deer, 25 woodcock a season; 5 hares or rabbits, 5 squirrels, 4 quail, 20 ducks, 8 geese, 8 brant, 10 plovers, and 10 yellowlegs, but not more than 15 in all, 4 woodcock, 10 Wilson snipe, 25 in all of coots and gallinules a day.

Possession of waterfowl, coots, and gallinules permitted during first 10 days of close season.

⁶⁴ *Utah:* Commissioner may open and fix seasons and bag limits on quail, pheasants, grouse, sage hens, and doves.

⁶⁵ Nonresident not permitted to kill deer.

⁶⁶ *Vermont:* Landowner, member of his family, or authorized employee may kill deer doing damage to his fruit trees or crops; but the person under whose direction a deer is so killed must, within 12 hours, report the matter in a signed statement to the nearest fish and game warden. Deer may also be killed at any time in orchard zones established by the commissioner, but such killing must forthwith be reported to the owner of the orchard and the county warden.

Sale: Sale of all protected game birds prohibited; deer may be sold during open season and for a "reasonable time thereafter," and hares and rabbits during the open season. Head and hide of deer legally taken may be sold.

Export: Export prohibited of all protected game, except hares and rabbits; provided, a nonresident licensee may export one deer and one day's bag limit of game birds under permit, but must accompany shipment; resident may export (if not for sale) one day's bag limit of game birds under special permit from commissioner. Packages containing game delivered to a common carrier for transportation must be tagged to show the number and kind of such game therein, names of consignor and consignee, station from which shipped, destination, and number of license.

VIRGINIA.

Open seasons: ⁶⁷

Dates inclusive.

Deer (see exceptions).....	Oct. 1-Feb. 1.
<i>Exceptions:</i> In Chesterfield, Mecklenburg, Prince George, and Surry Counties.....	
In Buckingham, Cumberland, Fluvanna, and Goochland Counties.....	Oct. 1-Jan. 1.
In Alleghany, Bath, Bland, Botetourt, Craig, Franklin, Giles, Highland, Montgomery, Patrick, Pulaski, Rockbridge, Rockingham, Russell, and Wythe Counties (1921).....	Nov. 1-Jan. 15.
Elk ⁶⁸ (except in national forest areas, no open season).....	Dec. 15-Dec. 31.
Rabbit ⁶⁹	Nov. 1-Feb. 1.
Squirrel ⁶⁹ (see exceptions).....	Aug. 15-Feb. 1.
<i>Exceptions:</i> Brunswick, Caroline, Charles City, Greenville, James City, New Kent, Spotsylvania, Stafford, Warwick, and York Counties.....	
In Buckingham, Cumberland, Fluvanna, and Goochland Counties.....	Nov. 1-Feb. 1.
In Loudoun.....	Nov. 1-Jan. 15.
In Isle of Wight and Southampton.....	June 1-Oct. 31.
In Rappahannock.....	Sept. 1-Jan. 15.
In Shenandoah.....	Nov. 1-Jan. 31.
In Warren.....	Aug. 15-Oct. 1.
Quail or partridge, pheasant or grouse, wild turkey (see exceptions).....	Nov. 15-Jan. 1.
<i>Exceptions:</i> In Buckingham, Cumberland, Fluvanna, and Goochland Counties.....	
West of Blue Ridge (except in Clarke County, Nov. 15-Jan. 1).....	Nov. 1-Jan. 15.
Doves (in Buckingham, Cumberland, Fluvanna, and Goochland Counties, Nov. 1-Dec. 15).....	Nov. 1-Dec. 31.
Duck, coot, mudhen, gallinule.....	Sept. 1-Dec. 15.
Goose, brant, Wilson snipe or jacksnipe.....	Nov. 1-Jan. 1. ⁶⁹
Black-bellied and golden plovers, yellowlegs (in Buckingham, Cumberland, Fluvanna, and Goochland Counties, Nov. 1-Nov. 30).....	Nov. 1-Jan. 31. ⁶⁹
Woodcock.....	Aug. 16-Nov. 30.
Rail, other than coot and gallinule (in Buckingham, Cumberland, Fluvanna, and Goochland Counties, Nov. 1-Nov. 30).....	Nov. 1-Dec. 31.
Reedbird ⁷⁰	Sept. 1-Nov. 30.
No open season: Swans, wood duck, elder ducks, auks, bitterns, sandhill crane, fulmars, gannet, grebes, gulls, herons, loons, murreas, petrels, shearwaters, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).	Aug. 16-Nov. 15.

⁶⁷ Virginia: Boards of supervisors may shorten the open season in their counties and make other restrictions not repugnant to law, "and may include in such protection other game not specifically mentioned in this section." (Code 1919, sec. 3356.) These changes are not included in this table.

⁶⁸ Elk doing damage to private property may be killed at any time under permit of commissioner of game and inland fisheries. Residents of the State may kill rabbits and squirrels on their own lands at any time. The open season on elk, rabbits, and squirrels in Buckingham, Cumberland, Fluvanna, and Goochland Counties is Nov. 1-Jan. 15.

⁶⁹ Wild fowl may not be hunted on Wednesdays, Saturdays, and Sundays on Back Bay, Princess Anne County. Open season on waterfowl, coot, gallinule, and Wilson snipe in Buckingham, Cumberland, Fluvanna, and Goochland Counties, Nov. 1-Jan. 15.

⁷⁰ See order of the Secretary of Agriculture, p. 76.

Hunting licenses: Nonresident, \$10; alien, \$20 (alien owner of real estate resident for five years, same as resident). Resident: State, \$3; county of residence, \$1. Issued by clerks of circuit and corporation courts.

Nonresident may hunt on own land during open season without a license. Owner, members of family, and tenant of land residing thereon may hunt without license during open season on own or adjoining lands with consent of owner.

Bag limits and possession: One elk a season; 15 quail, 6 grouse (pheasant), 2 wild turkeys a day; 25 ducks, 8 geese, 8 brant a day, but not more than 35 in all a day in Back Bay, Princess Anne County; 15 in all of plover and yellowlegs, 25 Wilson snipe, 6 woodcock, 50 sora and 25 in all of other rails, coots, and gallinules, 25 doves, a day. Possession of geese, brant, Wilson snipe, and dove, and of woodcock (except west of the Blue Ridge) permitted during first 10 days of close season.

Local bag limits are as follows: In Shenandoah County, 15 quail or partridges, 3 pheasants or grouse, and 2 wild turkeys a day. In Brunswick County, 15 quail and 2 turkeys a day.

Sale: Sale of quail or partridge, grouse or pheasant, wild turkey, reedbirds, and all other migratory birds prohibited; and sale of deer during close season prohibited.

Export: Export of all protected game (except sora, rabbits, and squirrels) is prohibited; provided that during open season nonresident may, under his hunting license, take with him out of State, or as baggage on same conveyance, 1 deer, 50 quail or partridges, 10 pheasants or grouse, 3 wild turkeys, 30 waterfowl, and 25 of each or 100 in all of plovers and snipe, if killed or captured by himself, shipped open to view, and plainly labeled with his name and address; but more than 2 days' limit of sora and other migratory birds may not be exported by one person in any one calendar week from any part of State. Any citizen of State may ship from State, as a gift and not for sale (which fact must be stated on shipping tag), 1 deer, 18 quail or partridges, 6 pheasants, 3 wild turkeys, 12 waterfowl, if open to view and plainly labeled with names and addresses of donor and donee and number of each kind of bird so shipped.

Back Bay, Princess Anne County: Nonresident licensee permitted to export as personal baggage 25 ducks, geese, or brant he has lawfully killed, but not for sale or barter; but not more than 16 geese or 16 brant in any one calendar week.

Shenandoah County: Licensee may take with him from county as personal baggage, open to view, if plainly labeled, 30 quail or partridges, 6 pheasants or grouse, 2 wild turkeys a season; and any citizen may ship the same quantity of game, as a gift, if not for sale.

WASHINGTON.

Open seasons:¹

West of Cascades—

Deer (see exceptions), goat.....*Dates inclusive.* Oct. 1–Nov. 1.

Exceptions: Deer in Island and San Juan Counties, Jan. 1, 1921; does in Skagit, Snohomish, and Whatcom Counties, no open season.

Bear.....Sept. 1–May 1.

Quail, ruffed grouse, native pheasant, Chinese pheasant (see exception), blue grouse, ptarmigan.....Oct. 1–Oct. 15.

Exception: Chinese pheasant in Clallam, Kitsap, and Skamania Counties, no open season.

Duck, goose, brant, coot.....Oct. 1–Jan. 15.

Black-bellied and golden plovers, Wilson snipe or jacksnipe, yellowlegs.....Oct. 1–Dec. 15.

Rail.....Oct. 1–Nov. 30.

East of Cascades—

Deer (Kittitas County, Oct. 15–Dec. 1).....Oct. 1–Nov. 15.

Bear.....Sept. 1–May 1.

Goat.....No open season.

Ruffed grouse (native pheasant), blue grouse (see exceptions).....Sept. 1–Nov. 15.

Exceptions: In Asotin (in precincts of Clarkston, South Clarkston, and West Clarkston, no open season), Garfield, and Walla Walla, Aug. 15–Oct. 1. *Ruffed grouse* in Columbia, Kittitas, and Yakima Counties, no open season. *Blue grouse* in Columbia County, no open season; in Spokane County, Oct. 1, 1919.

Quail in counties of Asotin (in precincts of Clarkston, South Clarkston, and West Clarkston, no open season), Garfield, and Walla Walla.....Oct. 1–Oct. 10.

Prairie chicken in Stevens County.....Sept. 15–Oct. 1.

¹ *Washington:* County game commission, with consent of State warden, may shorten, close, or open season on upland game birds.

Open seasons—Continued.

Dates inclusive.

East of Cascades—Continued.

Prairie chicken in Ferry and Okanogan Counties	Sept. 15–Nov. 1.
Sage hen, Hungarian partridge, male Chinese and English pheasants in Kittitas County	Oct. 1–Oct. 10.
Bob-white quail in Spokane County	Oct. 1–Nov. 1.
Hungarian partridge in Lincoln, Spokane, and Stevens Counties	Oct. 1–Nov. 15.
Chinese pheasants in Benton, Stevens, and Yakima Counties	Oct. 1–Oct. 15.
Duck, goose, brant, coot	Sept. 16–Dec. 31 ⁷²
Black-bellied and golden plovers, Wilson snipe or jacksnipe, yellowlegs	Oct. 1–Dec. 15.
Rail	Sept. 16–Nov. 30.
No open season: ⁷¹ Moose, elk (1925); fawns, caribou, mountain sheep, squirrels (gray, black, fox), quail, prairie chicken, sage hens, introduced birds (except as above), turkey, and dove; swans, wood duck, elder ducks, auklets, auks, bitterns, little brown and sandhill cranes, fulmars, grebes, gullmots, gulls, herons, jaegers, loons, murrelets, petrels, band-tailed pigeon, puffins, shearwaters, terns, and all shore birds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).	
Hunting and fishing licenses: Nonresident: Hunting and fishing, State, \$10; fishing, county, \$2. Resident: State, \$5; county, \$1. Issued by county auditors.	
No license required of honorably discharged Union soldiers of Civil War to hunt or fish, or of women and persons under 16 to fish, if residents.	
Bag limits and possession: One deer in counties east of Cascades. Two deer (1 buck in Skagit, Snohomish, and Whatcom), 1 goat in counties west of Cascades.	
Five in all of partridge, grouse, prairie chickens, Hungarian partridge, Chinese or English pheasant a day or in possession; 10 quail a day; 10 upland birds, but in no event to include more than 5 upland birds other than quail, and 25 in all of upland birds a week. In Kittitas County 2 male Chinese or English pheasants in bag of 5 upland birds; 20 ducks, geese, brant, golden plover, yellowlegs, Wilson snipe a week (week ends at midnight Saturday), but not more than 8 geese, 8 brant, 15 in all of plovers and yellowlegs a day; 30 ducks, geese, brant in possession; 50 sora and 25 in all of other rails, coots, and gallinules. Possession during close season permitted under permit, but migratory birds shall not be possessed longer than the first 10 days after close of open season.	
Sale: Sale of all protected game prohibited.	
Export: Export of all protected game prohibited.	

WEST VIRGINIA.

Open seasons:

Dates inclusive.

Rabbit (except on own land at any time)	Oct. 1–Dec. 31.
Squirrel	Sept. 15–Nov. 30.
Ruffed grouse (pheasant)	Oct. 15–Nov. 30.
Quail (Virginia partridge)	Nov. 1–Nov. 30.
Duck, goose, brant	Oct. 1–Dec. 31.
Coot, gallinule	Sept. 16–Dec. 31.
Wilson snipe or jacksnipe	Oct. 15–Dec. 14.
Black-bellied and golden plovers, yellowlegs	Sept. 16–Dec. 14.
Woodcock	Oct. 1–Nov. 30.
Rail (ortolan), other than coot and gallinule	Sept. 1–Nov. 30.
No open season: Deer (1922); elk (1927); wild turkey (1921); dove, imported pheasants, capercaillie, and other introduced foreign game birds; swans, wood duck, bitterns, sandhill crane, grebes, gulls, herons, jaegers, loons, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).	
Maximum licenses: ⁷³ Nonresident, \$18; resident, \$1; issued by county clerk. Aliens not game not entitled to hunt. License issued to minor under 15 on consent of parent or guardian not incumbent landowner, his children, and tenants may hunt on own land during	
⁷⁴ Elk doing without a license. Unlawful to hunt on inclosed or improved lands of commissioner of without written permission of owner.	
in Buckingham, Cumberland game commission, with consent of State warden, may shorten,	
⁷⁵ Wild fowl may not on upland game birds.	
Princess Anne County. Waterfowl on Columbia or Snake Rivers or within one-fourth Buckingham, Cumberland counties of Benton, Columbia, Douglas, Franklin, Garfield, Grant,	
⁷⁶ See order of the Walla Walla, Whitman, and Yakima.	
: Fishing license: Nonresident, \$5, issued by county clerk.	

Bag limits and possession: Ten squirrels a day, 70 a season; 12 quail a day, 60 a season; 5 ruffed grouse a day, 20 a season; 25 ducks, 8 geese, 8 brant, 6 woodcock, 25 Wilson snipe, 15 in all of plovers and yellowlegs, 50 sora, and 25 in all of other rails, coot, and gallinules a day. Possession of migratory birds permitted during first 10 days of close season; other game during first 20 days thereof.

Sale: Sale prohibited of all protected game, except rabbits may be sold during open season. **Export:** Export prohibited of deer, venison, squirrel, quail, ruffed grouse (pheasant), wild turkey, woodcock, geese, brant, ducks, plover, snipe. Not more than two days' limit of other migratory birds may be exported by one person in any one calendar week.

Miscellaneous: Unlawful to discharge firearms across any public road, within 400 feet of any schoolhouse, or on the lands of another within 600 feet of an occupied dwelling house.

WISCONSIN.

Open seasons:

Dates inclusive.

Deer in Pierce, Barron, Eau Claire, Clark, Wood, Lincoln, Langlade, Shawano, Oconto, and all counties north thereof (except Marathon)-----Nov. 21-Nov. 30.

In Marathon and rest of State-----No open season.

Rabbit (see exception)-----Oct. 15-Jan. 16.

Exception: In Columbia, Crawford, Grant, Richland, and Vernon Counties-----Unprotected.

Squirrels (see exception)-----Oct. 15-Jan. 1.

Exception: In Dodge, Kenosha, Milwaukee, Ozaukee, Racine, Washington, and Waukesha Counties-----No open season.

Hungarian partridge in Jefferson and Waukesha Counties only-----Sept. 7-Sept. 11.

Duck, coot or mud hen, gallinule-----Sept. 16-Dec. 10.

Goose, brant, Wilson snipe or jacksnipe, black-bellied and golden plovers, yellowlegs-----Sept. 16-Dec. 20.

Rail, other than coot and gallinule-----Sept. 16-Nov. 30.

No open season: Elk, moose, quail, pheasants (Chinese, English, Mongolian), Hungarian partridge (except as above), woodcock, dove, ruffed grouse, spruce hen, sharptailed grouse, prairie chicken (1921); swans, wood duck, elder ducks, auks, bitterns, little brown, sandhill, and whooping cranes, grebes, guillemots, gulls, herons, loons, murres, terns, and all shore birds (except Wilson snipe, black-bellied and golden plovers, and yellowlegs).

Hunting and fishing licenses: Nonresident: All game, \$50; all game (except deer), \$25; all fish, \$3; all fish (except trout), \$2 (not required in outlying waters or of person under 16); settlers, \$1; guide, \$1. Issued by commission. Resident: Game, \$1 (deer tag, 10 cents additional). Issued by county clerks.

Hunting licenses not issued to persons under 15 or to aliens. Hunting prohibited in fields of growing grain or on lands of another without consent of owner.

Bag limits and possession: One deer a season; squirrels, 5 a day; rabbits, 5 a day in counties where protected; other counties no limit; 2 Hungarian partridges a day; 8 geese, 8 brant, but not more than 10 in all a day. Duck (including coot or mud hen), plovers, snipe, rail, rice hen, 15 a day; mixed bag limit of 20 a day is permitted, but must not contain more than 15 of any one variety; 15 yellowlegs, but not more than 15 in all of plovers and yellowlegs a day.

Possession at any time of deer duly tagged permitted for private use by person killing it. Possession at any time prohibited of game by person without hunting license or scientist's certificate.

Sale: Sale of all protected game prohibited (except rabbit). Rabbits may be sold during open season.

Export: Export of all protected game prohibited, except nonresident licensee may transport, during last 10 days of November, 1 deer duly tagged if he accompanies shipment and may take in his personal possession, openly, a mixed bag of not more than 20 game birds legally killed, but not more than the bag limit for one day of any one variety.

Export permitted of specimens of birds and animals (except deer) taken under permits from State authorities and, if migratory birds are included, from Secretary of Agriculture for scientific purposes. Park boards allowed to ship, under permit of State conservation commission, live animals and game birds for park purposes.

WYOMING.

Open seasons:

Dates inclusive.

- Deer (with horns)-----Nov. 1--Nov. 30.
 Elk in Lincoln, Park, and Fremont Counties (except between Roaring Fork Creek and Big Sandy River on west slope of Wind River Mountains in Bridger National Forest, and north of Big Wind River and south of Sweetwater River in Fremont County)-----Oct. 1--Nov. 30.
 Sheep (mature males) in Lincoln, Park, and Fremont Counties only-----Oct. 15--Nov. 15.
 Sage grouse-----Aug. 15--Sept. 1.
 Duck, goose, coot, gallinule, black-bellied and golden plovers, • Wilson snipe, yellowlegs-----Sept. 16--Dec. 16.
 Rail, other than coot and gallinule-----Sept. 1--Nov. 30.
No open season: Elk (except as above), does and fawns, moose, antelope, quail, Mongolian pheasants (1925); grouse (other than sage grouse) (1923); dove, swans, wood duck, bitterns, little brown and sandhill cranes, grebes, gulls, herons, loons, terns, and all shore birds (except Wilson snipe or jacksnipe, black-bellied and golden plovers, and yellowlegs).
Hunting and fishing licenses: Nonresident: General, \$50; nonresident hunting big game must be accompanied by a guide, but not more than 3 may hunt under one guide: bear, \$10; birds and fish, \$5; fish, \$3. Allen: Gun and fish, \$25 (not required of holder of \$50 hunting license or of persons engaged in herding sheep); fish, \$3; resident allen, fish, \$2. Resident: General, \$2.50 (not issued to minor under 16); birds, \$1 (not issued to minor under 14); fish, \$1. Guide: Citizen only, \$10 (bond, \$500—may guide party of 3 nonresidents at one time). Licenses issued by justice of peace and assistant and deputy wardens. Unlawful to hunt on inclosed lands of another without consent of owner.
Bag limits and possession: One deer, 1 elk, 1 sheep, a season; 18 birds, of which not more than 4 may be sage hens (2 sage hens in Laramie and Sheridan Counties), a day or in possession, but must not include more than 8 geese, 8 brant, or 15 in all of plovers and yellowlegs.
Sale: Sale of all game of State prohibited: provided, the sale of game (except edible portion) is permitted when properly tagged. Justice of peace issues tags (fee, 25 cents) under affidavit that game was lawfully captured or killed. No sale of migratory birds permitted.
Export: Export of all protected game prohibited: provided, game may be exported if properly tagged by a justice of the peace, fee 25 cents. Game tags issued under affidavit that game was lawfully killed, and, if for edible portion, that it is not for sale. Smithsonian Institution or other well-known scientific institutions may export any game animals and birds under permit of State game Commission. Exchange of game animals and birds for liberation in Wyoming allowed under permit of the State game commission. Not more than 50 ducks, 16 geese, 16 brant, 50 Wilson snipe, 30 in all of plovers and yellowlegs, or 50 in all of rails, coots, and gallinules may be exported by one person in any one calendar week.

Canada.

Under the act of August 29, 1917, as amended in 1919, to give effect to the migratory-bird treaty between the United States and Great Britain the Governor General in council has promulgated regulations for the protection of migratory birds in Canada.⁷⁴ These regulations restrict the hunting of migratory game birds not protected throughout the year to a period not exceeding three and one-half months between September 1 and February 28, inclusive, in all except the Maritime Provinces, where the three and one-half months open season on shore-birds opens August 15 and closes November 30. Other provisions of the regulations fix bag limits on migratory game birds and prescribe the manner in which they may be taken and the appliances that may be used therefor.

Canada also has a general law prohibiting export of deer (except those raised on private preserves), wild turkey, quail, partridge, prairie fowl, and woodcock, but, subject to Provincial laws, a nonresident licensee, under permit of the collector of customs of the port from which export is made, may export, during

⁷⁴ Full text of the regulations, as amended May 11, 1920, will be found on pages 76-82.

the open season in the Province where killed or within 15 days thereafter, the carcasses or parts thereof of one moose and three deer, except from Yukon Territory the hides and heads only of 2 moose, 6 caribou, and 6 deer may be exported, but no person may export any moose or deer or parts thereof on more than two occasions during one calendar year. The ports of export are Halifax and Yarmouth, Nova Scotia; McAdams Junction, St. John, and St. Stephens, New Brunswick; Montreal, Quebec, Sherbrooke, Beebe Junction, and St. Armand, Quebec; Bridgeburg, Kingston, Ottawa, Port Arthur, Prescott, Niagara Falls, Sarnia, Sault Ste. Marie, Toronto, and Windsor, Ontario; Emerson, Manitoba; North Portal, Saskatchewan; Coutts, Alberta; Kingsgate and Wanitla, British Columbia; White Horse, Yukon Territory; and at all other custom ports and outports on the frontier of the United States; and such others as the minister of customs may designate.

ALBERTA.

- Open seasons:**⁷⁵
- | | <i>Dates inclusive.</i> |
|--|-------------------------|
| Deer (male), bull moose, caribou..... | Nov. 1-Dec. 14. |
| Sheep (male), goat..... | Sept. 1-Oct. 31. |
| Grouse, partridge, prairie chicken, ptarmigan..... | Oct. 15-Oct. 31. |
| Hungarian partridge..... | Oct. 1-Oct. 31. |
| Duck, goose, brant, Wilson snipe or jacksnipe, black-breasted and golden plovers, yellowlegs, rail, coot, gallinule..... | Sept. 1-Dec. 14. |
- No open season:** Elk or wapiti, buffalo, females of deer, moose, sheep, young of all big game, antelope (1925); pheasant, swans, wood duck, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, jaegers, loons, terns, and all shore birds (except Wilson snipe or jacksnipe, black-breasted and golden plovers, and yellowlegs).
- Hunting licenses:** Nonresident: General, \$25; bird, \$5. Resident: Big game, \$2.50; birds, \$2.25; not required of farmer or member of family residing with him on farm; guide, \$2.50; market hunter, \$5; game dealer, \$10. Farmers or their sons residing on own land, big game, \$1. Taxidermist, \$5. Issued by minister of agriculture. Residents north of latitude 55° may also take one head of big game (except elk or buffalo) without big-game license.
- Bag limits:** Deer, moose, caribou, 1 of each species, 2 sheep, 2 goats a season; grouse, partridge, prairie chicken, ptarmigan, 10 a day, 100 a season; Hungarian partridge, 5 a day, 25 a season; 30 ducks a day, 200 a season; 15 geese, 15 brant, 25 in all of rails, coot, and gallinules, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day.
- Sale:** Sale of grouse, partridge, prairie chicken, ptarmigan, and Hungarian partridge prohibited. Other game birds may be sold under license during open season. The migratory game birds and the flesh of big game may be sold under \$10 license. Heads of big game before being sold must be stamped by minister of agriculture at fee of \$5 for elk, caribou, moose, sheep; and \$2 for deer, antelope, and goat.
- Export:** Export of all protected game prohibited, except minister of agriculture, may grant permits for export of game at the rate of \$5 for each head of big game and \$1 per dozen for game birds. The holder of a general nonresident license may take with him out of the Province as trophies heads, skins, and hoofs of big game legally killed by him. Any person may export mounted or branded heads at a fee of \$1 for each head. Export of migratory birds prohibited during close season.

BRITISH COLUMBIA.⁷⁶

[1920 regulations on upland game birds not received.]

- Open seasons:**⁷⁶
- | | <i>Dates inclusive.</i> |
|---|-------------------------|
| Moose (male) in Atlin, Fort George, Omineca, and Cariboo Electoral Districts..... | Sept. 1-Dec. 15. |
| In Columbia Electoral District..... | Oct. 1-Nov. 15. |
| In rest of Province..... | No open season. |
| Caribou (male) (see exception)..... | Sept. 1-Dec. 15. |
| Exception: South and east Canadian Northern Pacific Railway..... | No open season. |

⁷⁵ *Alberta:* North of latitude 55° any game animal or bird, except elk and buffalo, may be killed at any time if needed for food.

⁷⁶ *British Columbia:* Open seasons on big game and upland game fixed annually by order in council, copies of which may be had from the secretary of the game conservation board, Vancouver, British Columbia.

Open seasons—Continued.*Dates inclusive.*

Mountain sheep (male), north Grand Trunk Pacific Railway	Sept. 1–Nov. 15.
In Columbia, Cranbrook, and Fernie Electoral Districts	Oct. 1–Nov. 15.
In rest of Province	No open season.
Mountain goat	Sept. 1–Dec. 15.
Bear (see exception)	Sept. 1–June 30.
<i>Exception: Unlawful to trap bear south of Canadian Pacific Railway.</i>	
Duck, goose, brant, rail, coot, gallinule, Wilson snipe or jacksnipe, black-breasted and golden plovers, yellowlegs:	
Northern and Eastern Districts	Sept. 4–Dec. 19.
Western District—north of fifty-first parallel	Sept. 11–Dec. 26.
Duck, rail, coot, gallinule, Wilson snipe or jacksnipe, black-breasted and golden plovers, yellowlegs:	
Western District—south of fifty-first parallel	Oct. 16–Jan. 31.
Goose, brant:	
Western District—south of fifty-first parallel	Nov. 13–Feb. 28.
No open season: Buffalo, elk, young of deer and goat, and females and young of moose, caribou, and sheep; wood duck, band-tailed pigeon, auklets, auks, bitterns, fulmars, grebes, guillemots, gulls, herons, jaegers, loons, murrelets, petrels, puffins, shearwaters, terns, and all shore birds (except curlew, Wilson snipe, black-breasted and golden plovers, and yellowlegs). Seasons on swans, cranes, and curlew fixed by Provincial authorities. Hunting big game prohibited on Kalen and Queen Charlotte Islands.	
Hunting and fishing licenses: Nonresident: General, \$25 and \$25 additional for each grizzly bear, moose, sheep, wapiti, or caribou, \$15 additional for each black or brown bear, mountain goat, or mule deer, and \$5 additional for every deer of any other species shot by him; bear, January 1–July 1, \$25; angling, season \$5, or \$1 per day up to five days; British subject, birds, \$5 per week. Resident and members of army, navy, air forces, or militia on duty in Province: Deer and birds, \$2.50; big game and birds, \$5. Big game, birds, and trapping, \$10 (holder must report within two months after expiration of license number of big game or fur animals taken); guide, \$5. Taxidermist, \$5. Issued by warden or any person authorized by him.	
No fee required of farmer holding over 10 acres of land or member of family for license to hunt birds and deer on land on which he resides. Free license granted to prospector under certain conditions upon production of free miner's certificate. No license issued to person under 18 without written consent of parent or guardian, and then to hunt with firearms only under supervision of licensed adult. Unlawful to hunt on cultivated, cleared, or inclosed land without owner's consent.	
Badge to be worn by licensee. Firearms not to be carried without license.	
Bag limits and possession: Three deer of any species, 4 in all; 1 elk, 1 moose, 2 caribou, 2 goats, 2 sheep (1 in Columbia, Cranbrook, and Fernie electoral districts), a season; 20 ducks a day, 250 a season; 10 geese a day, 50 a season; 15 brant, 25 in all of rail, coot, and gallinule, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day. (Limits on other species fixed by orders in council.) Game may be possessed for two weeks after close of open season. Unlawful for a dealer in skins to possess the skin of any wapiti (elk) or deer.	
Sale: Sale of migratory game birds prohibited and of all other game, except under regulations of lieutenant governor in council.	
Sale of big game without head attached and game birds without plumage prohibited. Heads of big game killed without and imported into Province may be sold when branded. Fees: Moose and elk, \$5; mountain sheep, \$4; caribou, \$3.	
Export: Export prohibited of all protected game except under permit of the Game Conservation Board.	
Miscellaneous: Use of automatic guns prohibited. Pump guns capable of holding only one cartridge in magazine may be used. Unlawful to discharge, carry, or possess any loaded shotgun or rifle in any vehicle on a highway or railway.	

MANITOBA.**Open seasons:***Dates inclusive.*

Deer, moose, caribou, or reindeer, elk or wapiti, antelope or cabri (males)	Dec. 1–Dec. 10.
Ptarmigan	Oct. 1–Oct. 20.
Prairie chicken, partridge, grouse	Oct. 15–Oct. 22.
Duck, goose, brant, rail, coot, gallinule, Wilson snipe, black-breasted and golden plovers, yellowlegs, woodcock	Sept. 15–Nov. 30.

* For definition of Districts see Regulation 2, pp. 77–78.

No open season: Bison or buffalo, females and young of big game, dove; quail, pheasant, Hungarian partridge, introduced game bird (1927); swans, wood duck, elder ducks, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, jaegers, loons, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-breasted and golden plovers, and yellowlegs).

Hunting licenses: Nonresident alien, big game, \$25; birds, \$25. Nonresident British, big game, \$15; birds, \$10. Resident, big game, \$4; birds, \$1. Issued by minister of agriculture. Hunting prohibited on inclosed or cultivated land or land covered by build-ings or water, without consent of owner. No license required of farmers or members of family to hunt on farm on which they reside. Holder of resident bird license required, on or before December 15, to return license with sworn statement that he has not violated the act.

Bag limits and possession: One in all of deer, moose, caribou, elk, and antelope a season; 15 ptarmigan a day, 50 a season; prairie chicken, partridge, grouse, 25 in all a sea-son; 20 ducks a day in September, 40 a day in October and November, 250 a season; 10 geese, 15 brant, 25 in all of rails, coot, and gallinules, 10 woodcock, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day. Possession of ptarmigan, prairie chicken, partridge, and grouse allowed for 10 days, and of ducks for four months after close of hunting season. Venison for private use may be possessed at any time on proof of legal killing. Heads and hides of big game legally taken, within or with-out Province, may be possessed at any time.

Sale: Sale prohibited of deer, elk, moose, caribou, antelope (except heads and hides), and all protected game birds.

Export: Export prohibited of all protected game except under permit issued by department of agriculture. No permit shall be issued for export of ptarmigan, prairie chicken, partridge, grouse, geese, ducks, or entire carcass of any moose, elk, caribou, or deer; provided, nonresident licensee under permit issued free may export carcass of moose, caribou, or deer, and not more than 50 geese and 50 ducks killed by him. (No duck shall be exported before Oct. 1.) Export of migratory birds prohibited during close season.

Miscellaneous: Hunters must wear complete outer suit and cap of white material. Auto-matic guns prohibited in hunting waterfowl and ptarmigan.

NEW BRUNSWICK.

Open seasons:

Dates inclusive.

Deer (see exception), moose (bulls)-----Sept. 15-Nov. 30.

Exception: Deer on Grand Manan and Campobello

Islands-----Oct. 1, 1922.

Duck, goose, brant, rail, coot, gallinule-----Sept. 15-Dec. 31.

Woodcock, jacksnipe or Wilson snipe-----Sept. 15-Nov. 30.

Black-breasted and golden plovers, yellowlegs-----Aug. 15-Nov. 30.

No open season: Caribou (1921); calf under 3 years and cow moose; pheasant; partridge (1921); swans, wood duck, elder ducks, auks, bitterns, fulmars, gannet, grebes, gulle-mots, gulls, herons, jaegers, loons, murre, petrels, puffins, shearwaters, terns, and all shorebirds (except woodcock, Wilson snipe or jacksnipe, black-breasted and golden plovers, and yellowlegs).

Hunting licenses: Nonresident: General, \$50; bird, \$15; trout, \$10; salmon, \$25. Resi-dent: Big game, \$2; sinkbox for waterfowl, \$1; taxidermist, \$1; guide, \$1; camp help, \$1. Big game license not issued to person under 18. Issued by minister of lands and mines. Nonresident licensee must have registered guide.

Bag limits and possession: Two deer, 1 moose (lumber camp limited to 2 moose) a season; 20 ducks, 10 partridges, 25 ducks, 15 geese, 15 brant, 25 in all of rails, coot, gallinules, 10 woodcock, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day. Game may be kept for personal use in cold storage during close season under permit.

Sale: Sale of carcass of moose and deer (except head or hide) and of migratory game birds prohibited; of other game during close season; provided game (except migratory birds) may be sold during life of 10-day permit applied for within 10 days after close season. Keepers of hotels, inns, etc., may serve game during open season and 15 days thereafter. Hides and skins of animals may be sold under license by nonresidents or aliens, fee, \$50; and residents, fee, \$10.

Export: Export of all game prohibited, except that minister of lands and mines may issue license to export game alive or dead.

Miscellaneous: Automatic guns prohibited in hunting big game and waterfowl.

⁷⁸ *New Brunswick:* Except in the case of partridge the prohibition applies only to common carriers.

NORTHWEST TERRITORIES.⁷⁰Open seasons:⁸⁰

Dates inclusive.

Deer and moose (males only), mountain goat.....	Sept. 1-Apr. 1.
Mountain sheep, caribou.....	{ Aug. 1-Oct. 1. Dec. 1-Apr. 1.
Partridge, prairie chicken, ptarmigan, and other grouse.....	Sept. 1-Jan. 1.
Duck, goose, brant, rail, coot, gallinule, Wilson snipe, black-breasted and golden plovers, yellowlegs.....	Sept. 1-Dec. 14.
No open season: Buffalo or bison; musk ox, wapiti or elk, does, cow moose; females of caribou, sheep, and goat with young, and young of any of such animals; swan (1928); wood duck, elder duck (1923). Hunting or trapping prohibited on Victoria and Banks Islands; auks, bitterns, little brown and sandhill cranes, fulmars, grebes, guillemots, gulls, jaegers, loons, murre, terns, and all shorebirds (except Wilson snipe or jack-snipe, black-breasted and golden plovers, and yellowlegs).	
Hunting and trapping licenses: Nonresident, \$50; nonresident British subject, \$25; resident, \$2; trading or trafficking in game: nonresident, \$100; nonresident British subject, \$50; resident, \$5. Issued by commissioner of Dominion parks. Native-born Indians, Eskimos, or half-breed bona fide residents of Northwest Territories may hunt without a license.	
Bag limits: Two bull moose, 2 male deer, 4 caribou; mountain sheep, 2 of any species, 3 in all; mountain goat, 2 of any one species a season; 25 ducks, 15 geese, 15 brant, 25 in all of rails, coot, and gallinules, 10 woodcock, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day.	
Sale: Sale of protected game during close season prohibited.	
Export: Export of the meat of any game prohibited.	

NOVA SCOTIA.

Open seasons:

Dates inclusive.

Deer, male (except on Cape Breton Island, no open season) ⁸¹	Oct. 16-Oct. 31.
Moose, bulls (except on Cape Breton Island, no open season) ⁸¹	Oct. 1-Nov. 15.
Caribou, bulls, in Inverness and Victoria Counties only ⁸¹	Sept. 16-Oct. 15.
Hare, rabbit (see exception).....	Dec. 1-Jan. 31.
<i>Exception:</i> On Cape Breton Island.....	
Duck, goose, brant, rail, coot, gallinule.....	Sept. 15-Dec. 31.
Black-breasted and golden plovers, yellowlegs.....	Aug. 15-Nov. 30.
Woodcock, Wilson snipe.....	Sept. 15-Nov. 30.
No open season: Females and young of deer, moose, and caribou, Canada grouse (spruce partridge), pheasant; ruffed grouse (birch partridge), 1922. Swans, wood duck, elder ducks, auks, bitterns, fulmars, gannet, grebes, guillemots, gulls, herons, jaegers, loons, murre, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-breasted and golden plovers, and yellowlegs).	
Hunting licenses: Nonresident: All game, \$30; birds and small game, except woodcock and snipe, \$15; nonresident paying taxes equal to license fee, \$5; military or naval officer stationed in Province, \$5; resident alien, \$5; guide, resident, \$2. Issued by provincial secretary, game commissioners, and municipal clerks.	
Bag limits and possession: One deer, 1 moose, 1 caribou a season; 5 ruffed grouse, 25 ducks, 15 geese, 15 brant, 25 in all of rails, coot, and gallinules, 10 woodcock, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day. The green hide or fresh meat of big game may be possessed as follows: Moose, October 1 to November 20; deer, October 16 to November 3; caribou, September 16 to October 30.	
Sale: Sale prohibited of deer, caribou, pheasant, blackcock, capercaillie, Canada grouse (spruce partridge), chukar partridge, woodcock, Wilson snipe, or other shore birds.	
Moose (meat only) may be sold from October 4 to October 19 under certificate showing lawful killing; rabbit, December 4 to February 1; any game bird other than	

⁷⁰ "Northwest territories" means the northwest territories formerly known as Rupert's Land and the Northwestern Territory (except such portions thereof as are included in the Provinces of Ontario, Quebec, Manitoba, Saskatchewan, and Alberta and the Yukon Territory), together with all British territories and possessions in North America and all islands adjacent thereto not included within any Province, except the Colony of Newfoundland and its dependencies.

⁸⁰ Indians, Eskimos, bona fide inhabitants, explorers, and surveyors may take game, except buffalo, musk ox, or elk, and the eggs of birds when actually needing them to prevent starvation. Indians and Eskimos may take musk ox for such purposes.

⁸¹ *Nova Scotia:* Every person killing a deer, moose, or caribou must, within 10 days, make a written and signed report to the chief game commissioner showing his address and when and where such animal was killed.

Miscellaneous: Unlawful to use rifle or gun loaded with bullet to shoot waterfowl.

Open seasons: ⁸² *Dates inclusive.*

Deer (see exception) ----- Nov. 5—Nov. 20.

Exception: North of Canadian Government Railway (1920) --- Oct. 1-Nov. 30.

**Moose, caribou (bulls only) (cows and calves under 1 year of age,
no open season) (see exception)-----Oct. 1--Nov. 30.**

Exception: South of Canadian Pacific Railroad from Mattawa to Port Arthur-----Oct. 5—Nov. 20.

Hare ⁸³ ----- } Oct. 15–Nov. 15.
Dec. 23–Jan. 2.

Squirrel (black or gray), quail, pheasant, wild turkey----- Nov. 1—Nov. 15.

Grouse, prairie fowl, or partridge----- Oct. 15–Nov. 15.

Capercaillie-----Sept. 15-Dec. 15.

Woodcock-----Oct. 15--Nov. 14.

Duck, goose, brant, black-breasted and golden plovers, yellowlegs,

jacksnipe or Wilson snipe, rail, coot, gallinule.-----Sept. 1-Dec. 14.
No open season: Fawns, elk or wapiti, dove, swans, wood duck, elder ducks, auks, bitterns, little brown, sandhill, and whooping cranes, gannet, grebes, guillemots, gulls, herons, jagers, loons, murre, petrels, terns, and all shorebirds (except woodcock, Wilson snipe, black-breasted and golden plovers, and yellowlegs).

Hunting licenses: Nonresident: General, \$25. Resident: Moose and caribou, \$5; deer, \$3. Guide, \$2. Issued by department of game and fisheries.

Bag limits and possession: One deer, 1 bull moose, 1 caribou a season; 6 quail a day, 25 a season; 10 partridge a day; 25 ducks a day, 200 a season; 15 geese, 15 brant, 25 in all of rails, coot, and gallinules, 10 woodcock, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day. Two or more persons hunting together under license may kill an average of 1 deer each. Possession permitted during open season and until March 31 following of all game except migratory birds.

Sale: Sale of migratory game birds prohibited. All other native game may be sold during the open season by the person killing it, and by dealers during open season and until the following January 1, under license; hotels, restaurants, and clubs under license may sell during closed season. Imported game may be sold under special regulations and licenses. Game breeders may sell animals for breeding purposes under permit.

Export: The export of all wild game animals and birds is prohibited: provided, 1 deer, 1 bull moose, 1 bull caribou, and 100 ducks may be exported under nonresident hunting license if shipping coupon and, if required, affidavit of lawful killing be attached and contents of packages be open to view. Lawfully imported game and deer, moose, elk, or caribou in private ownership may be exported. Minister may issue permit for the export of game, dead or alive, at any time, except migratory birds during close season.

Miscellaneous: Use of automatic guns prohibited. Unlawful to enter with gun or dog into growing or standing grain without consent of owner.

Open seasons: *Dates inclusive.*

Hare, rabbit-----**Nov. 1-Feb. 1.**

Partridge (in alternate years, 1920, 1922, etc.)-----No open season.

Duck, goose, brant, rail, coot, gallinule-----Sept. 1-Dec. 14.

Woodcock, jacksnipe or Wilson snipe-----Sept. 15–Nov. 30.

Black-breasted and golden plovers, yellowlegs-----Aug. 15--Nov. 30.

⁸² **Ontario:** Lieutenant governor in council may alter close seasons in region north and west of French River, Lake Nipissing, and Mattawa River, and in the vicinity of Rondeau Park, and close for a definite period seasons for any game animal or nonmigratory game bird whose numbers have diminished.

⁵³ Hares may be killed during close season by any means other than shooting.

No open season: Swans, wood duck, elder ducks, bitterns, little brown crane, gannet, grebes, gulliemots, gulls, herons, jaegers, loons, murre, petrels, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe or jacksnipe, black-breasted and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, \$15. If applicant pays taxes on real estate valued at \$325, fee \$5; sons and brothers of residents returning for visit, \$2.50; guest, \$2. Issued by game inspectors and tax collectors. Hunting on inclosed lands without permission of owner prohibited.

Bag limits: Twenty-five ducks, 15 geese, 15 brant, 25 in all of rails, coot, and gallinules, 10 woodcock, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day.

Sale: Game lawfully killed may be sold, except migratory birds may not be sold during close season.

Export: Export prohibited of all game except geese and brant; provided nonresident licensee may carry out of Province 12 birds killed by himself if tagged and carried open to view. Export of migratory birds prohibited during close season.

Miscellaneous: Use prohibited of automatic, pump, machine gun, rifle, or other gun loaded with bullets in hunting game birds.

QUEBEC.

Open seasons: ⁸³

Dates inclusive.

Deer, bull moose (see exception), caribou..... Sept. 20-Dec. 31.

Exception: In Pontiac and Temiscaming counties..... Sept. 10-Dec. 31.

Hare Oct. 15-Jan. 31.

Bear Aug. 20-June 30.

Birch or swamp partridge..... Sept. 1-Dec. 14.

White partridge or ptarmigan..... Nov. 1-Jan. 31.

Duck, goose, brant, rail, coot, gallinule, woodcock, jacksnipe or Wilson snipe, black-breasted and golden plovers, yellowlegs..... Sept. 1-Dec. 14.

No open season: Cow moose, young of deer, moose, and caribou, swans, wood duck, elder ducks, auka, bitterns, fulmars, gannet, grebes, gulliemots, gulls, herons, jaegers, loons, murre, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock, Wilson snipe, black-breasted and golden plovers, and yellowlegs).

Hunting licenses: Nonresident: General, \$25 (members of incorporated hunting clubs, \$10). Resident, \$1 (not required of resident British subject hunting for own use); resident special, \$5 (3 deer and 3 caribou additional to limit). Issued by Minister of Colonization.

Bag limits and possession: Two deer, 1 moose, 2 caribou a season; 2 caribou and 3 deer under special resident license. Twenty-five ducks, 15 geese, 15 brant, 25 in all of rails, coot, and gallinules, 10 woodcock, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day. Game lawfully killed may be possessed until 15 days after close of open season.

Sale: Sale of birch or spruce partridge prohibited until October 1, 1920. Game lawfully taken may be sold from the third day of open season to and including the fifteenth day after expiration of open season, except the sale of migratory birds is prohibited during close season. Licensed hotels, restaurants, and clubs may serve game lawfully taken, except birch or spruce partridge.

Export: Export of moose, caribou, and deer, or parts thereof, prohibited except under permit issued from Minister of Colonization (fee not to exceed \$5); also under tags attached to nonresident license not later than 15 days after close of season; export of migratory birds prohibited during close season.

⁸³ *Quebec:* By a Dominion order in council, it is unlawful to capture, take, injure, or molest migratory game, migratory insectivorous, or other migratory nongame bird, or to take, injure, destroy, or molest their nests or eggs within the following areas:

"A strip of land 10 feet in depth, along the cliff and the cliff itself on the north and east sides of Bonaventure Island in the County of Gaspé;

"The Bird Rocks and a 1-mile zone surrounding the same;

"Perce Rock and a 1-mile zone surrounding the same, except that where the mainland is distant less than 1 mile from Perce Rock, the shore of such mainland shall constitute the boundary of the zone."

SASKATCHEWAN.

Open seasons:⁵⁴

Dates inclusive.

Deer, moose (males only), caribou.....Nov. 15-Dec. 14.⁵⁵

Prairie chicken (sharp-tailed or pinnated grouse).....Oct. 15-Oct. 31.

Duck, goose, brant, rail, coot, gallinule, Wilson snipe or jacksnipe,
black-breasted and golden plovers, yellowlegs.....Sept. 15-Dec. 31.

No open season: Antelope, buffalo, elk, and female of big game, other than caribou, and young of big game under one year of age.⁵⁶ Partridge (ruffed grouse), sage grouse, Canada or spruce grouse; swans, wood duck, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, loons, terns, and all shore birds (except Wilson or jacksnipe, black-breasted and golden plovers, and yellowlegs).

Hunting licenses: Nonresident: Big game, \$25; birds, \$15; domiciled in Canada, \$5; issued by minister of agriculture. Resident: Big game, \$5; birds, \$1.25. Issued by minister or agent. Bird license not required of residents hunting on land outside city, town, village, or hamlet on which they are actually domiciled. No license issued to person under 16 without written consent of parent or guardian. Big-game hunters must wear white suit and cap. Hunting prohibited on inclosed lands without consent.

Bag limits and possession: One moose, 2 deer, 2 caribou, but not more than 2 in all a season; prairie chicken, 6 a day, 30 a season; 50 in all of ducks, geese, and brant a day, 250 a season; 25 in all of rail, coot, and gallinule, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day. Game birds may be kept in licensed storage from September 16 to March 1 and flesh of big game from December 1 to April 1 if tagged with number and kinds of game, name of depositor, and number of his hunting license.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited; provided, minister of agriculture may grant permits to export for scientific purposes or propagation in public parks and zoological gardens 1 pair each species of big game and game birds upon payment of \$5, or for propagation a specified number on application of another Province or State. Minister may issue permits to export deer (fee \$2 per head) or other big game (fee \$5 per head), hides of big game (fee \$1 each), flesh of big game (fee \$1 for each 20 pounds or less), birds (except grouse family) (fee \$1 per dozen, limit 5 dozen per season). Nonresident licensee on leaving Province may take with him during open season personally under his license and permit big game and 100 game birds legally killed. Export of migratory birds prohibited during close season.

YUKON.

Open seasons:⁵⁷

Dates inclusive.

Deer, moose, caribou, sheep, goat (males only).....Aug. 1-Mar. 1.

Partridge, prairie chicken, grouse, ptarmigan, pheasant.....Sept. 1-Mar. 15.

Duck, goose, brant, rail, coot, gallinule, Wilson snipe or jacksnipe,
black-breasted and golden plovers, yellowlegs.....Sept. 1-Dec. 14.

No open season: Elk or wapiti, musk ox, bison or buffalo, and females of other big game; swans, elder ducks, cranes, grebes, gulls, jaegers, loons, terns, and all shorebirds (except Wilson snipe or jacksnipe, black-breasted and golden plovers, and yellowlegs).

Hunting licenses: Nonresident, \$100. Resident, \$25 (special license authorizing the killing of male moose and male caribou over 1 year of age at any time for food supplies in the Territory); licensee must make annual returns. Resident: Chief guide, \$20; assistant guide, \$10; camp helper, \$5. Issued by commissioner or game guardian.

Bag limits: Six caribou, 6 deer, 2 moose, 2 sheep, 2 goats a season; 25 ducks, 15 geese, 15 brant, 25 in all of rail, coot, and gallinule, 10 woodcock, 25 Wilson snipe, and 15 in all of plovers and yellowlegs a day.

Sale: Deer, moose, caribou, sheep, and goats lawfully taken may be sold during the open season and 60 days thereafter. Male moose and male caribou over 1 year of age killed by a resident under special license may be sold at any time for food upon obtaining certificate of lawful killing from a game guardian. License (fee, \$10) required to purchase and traffic in the flesh of moose or caribou. Licensee must make annual returns. Sale of migratory birds prohibited during close season.

⁵⁴ Saskatchewan: Lieutenant governor in council may extend close seasons over current year, within limits, on petition of six game guardians.

⁵⁵ Applies north of line between townships 34 and 35; south of said line no open season.

⁵⁶ Male moose having horns less than 6 inches in length deemed to be under one year of age.

⁵⁷ Yukon: Indians, explorers, surveyors, prospectors, miners, and travelers in need of food may take game during close season. Commissioner in council may alter seasons.

Export: Export of migratory birds prohibited during close season. Upon affidavit of lawful killing, commissioner may issue permit to export game. Export of raw hide of moose or caribou prohibited except under permit. Trophies, including head, hide, and hoofs, of big game lawfully killed by nonresident may be exported under his license and certificate of game guardian.

Colony of Newfoundland.

Open seasons:

Dates inclusive.

Caribou (except in a special region near Grand Lake, no open season)----- (Aug. 1-Sept. 30.
Oct. 21-Jan. 31.

Hare, rabbit----- Sept. 20-Jan. 1.⁸⁸

Ptarmigan, willow grouse or partridge, plovers, curlew, snipe, or
"other wild or migratory birds (except wild geese and crows)"---Sept. 20-Jan. 1.

No open season: Elk, moose.

Hunting and fishing licenses: Nonresident: Caribou, \$51; fish (salmon and sea trout), \$10.50. Guide, nonresident, \$50; resident, free.

Caribou licenses issued by game and inland fisheries board, stipendary magistrate, or justice of peace.

Unlicensed guides not to be employed. Guide shall not guide party of more than three sportsmen.

Bag limits: Three caribou (stags) a season by nonresident licensee; 2 stags, 1 doe by resident.

Sale: Caribou may be sold from August 1 to January 1; ptarmigan, willow grouse taken in open season may be sold until January 15; other birds may be sold during open season.

Export: Export for sale prohibited of caribou, partridge, willow or other grouse; provided, game and inland fisheries board may issue licenses to export caribou for breeding or scientific purposes. Licensee may export three stag caribou under hunting license and export permit (fee, 50 cents); resident may export antlers, head, or skin of caribou under export permit, but not, in either case, for sale.

Lower California—Northern District.

Open seasons: ⁸⁹

Dates inclusive.

Deer, antelope, quail, ducks, and other small game-----Oct. 1-Feb. 15.

No open season: Mountain sheep.

Hunting licenses: Fee, \$5; issued at any customhouse.

Miscellaneous: Hunting permitted only with shotgun or rifle.

DISPOSITION OF GAME RAISED IN CAPTIVITY.

Regulations adopted under the Federal migratory-bird treaty act, permitting the propagation and sale of migratory waterfowl,⁹⁰ pave the way for the upbuilding in this country of an industry from which many persons have been barred by lack of suitable legislation. It has been demonstrated that game animals and birds, especially certain species of migratory waterfowl, will yield satisfactory returns when propagated on farms and preserves. It is believed that the demand will far exceed the supply for a number of years, in view of the increased restrictions on the sale of native wild game and of the

⁸⁸ *Newfoundland:* Hare or rabbit may also be taken with trap or snare until March 1.

⁸⁹ *Lower California:* Seasons and other restrictions subject to modification from time to time by the governor. Undersecretary Terrazas has been commissioned by the governor of Lower California to prepare a comprehensive decree properly to protect all game. This decree, or game law, will be issued before the beginning of the coming season in October.

⁹⁰ Waterfowl are the only migratory birds that are permitted to be raised in captivity, and permits therefor must be obtained from the Secretary of Agriculture, Washington, D. C., in accordance with the regulations. (See Regulation 8, p. 73.) For Canadian regulations on propagation of migratory birds, see Regulation 8D, p. 80.

fact that migratory birds can no longer be sold on the market anywhere in the United States unless they have been reared in captivity in accordance with the law and regulations. The Department of Agriculture, acting in conjunction with State game officials, will aid so far as possible in establishing this industry, both in preparing drafts of suitable laws to be enacted by the various States and in assisting breeders to obtain eggs and breeding stock. The department is not and never has been in a position to furnish breeding stock or the eggs of any species of game bird for propagating purposes, contrary to frequent reports in the press, but it will assist legitimate enterprises by granting the necessary permits to propagate migratory waterfowl in captivity and to take birds or eggs for propagating purposes. Reasonable and proper regulations of Federal and State Governments will permit domesticated game to reach the market for consumption at all seasons and at the same time will prevent the infringement of laws to conserve the supply of native game.

Federal regulations: Under permit from the Secretary of Agriculture, Washington, D. C., and subject to the provisions of State laws relating thereto, migratory waterfowl may be possessed, sold, and transported at any time for propagation and the carcasses with heads and feet attached of propagated birds killed in any manner, except that they may be killed by shooting only during the open season for waterfowl in the State where killed, may be sold and transported at any time to any person for actual consumption, or to the keeper of a hotel, restaurant, or boarding house, retail dealer in meat or game, or a club, for sale or service to their patrons, who may possess such carcasses for actual consumption without a Federal permit; provided, that no migratory waterfowl killed by shooting shall be bought or sold unless each bird before attaining the age of four weeks shall have had removed from the web of one foot a portion thereof in the form of a "V" for identification purposes. (See Reg. 8, p. 73, for full details and requirements.)

About two-thirds of the States now have some special provision regulating possession, sale, or export of game raised in captivity. The following table giving a digest of the various State laws on the subject serves to show the lack of uniformity and the need of additional legislation to attain the results desired:

Arkansas: The commission may establish rules governing propagation of game in captivity and authorize the sale or export of such game under permit.

California: Game raised in captivity under breeder's license (fee, \$2.50) may be sold at any time for breeding purposes or may be sold under license and regulations of commissioners for food when properly tagged (fee, 3 cents a tag). All domesticated game (except deer) must be killed otherwise than by shooting.

Colorado: Game furnished from a private park or lake of class A may be sold by hotels and restaurants at any time. Game taken from licensed private parks may be sold or shipped at any time if accompanied by an invoice.

Connecticut: Deer, pheasants, and wild fowl raised in licensed preserves (fee, \$2) may be sold or transported at any time, when duly tagged, under regulations of commissioners of fisheries and game.

Delaware: Unlawful to kill, sell, or possess Hungarian partridge or pheasants except for scientific or propagating purposes.

District of Columbia: Hungarian partridge, English, ringneck, Mongolian, or Chinese pheasants raised in captivity may be sold at any time.

Georgia: Registered breeder may sell game for propagation.

Illinois: Game raised in captivity under a breeder's license (fee, \$5) may be sold for propagation purposes, or may be killed, sold, and transported for food at any time.

Indiana: Birds and animals bred and reared in captivity may be killed, sold, or transported at any time under certificate of inspection (fee, \$10) from the conservation commission.

- Iowa:** Game birds raised in captivity under license (fee, \$2) may be sold.
- Kansas:** Game raised in captivity may be transported for scientific or propagating purposes under permit of warden and \$1,000 bond.
- Kentucky:** Game birds and game animals bred in captivity under permit may be sold, transported, or otherwise disposed of at any time when duly tagged.
- Louisiana:** Game raised in captivity under \$5 license may be sold alive for stocking or breeding purposes, and may be killed, transported, and sold for food at any time if tagged with metal tag. Traffic in birds killed by shooting prohibited.
- Maine:** Game raised in captivity under a \$2 breeder's license may be killed, sold, or transported at any time under regulations of commissioners.
- Maryland:** Elk and imported and native deer raised in licensed preserve (fee, \$5) may be sold, dead or alive, at any time. (In Allegany and Garrett Counties white-tailed deer native to the State must be branded three months prior to killing.) The propagation and killing of English or ringneck pheasants in captivity is permitted, except that hen pheasants may be killed only during the open season (Nov. 10 to Jan. 1) by means other than shooting. In Washington County game animals and birds reared in licensed preserves (fee, \$10) may be sold for propagation only.
- Massachusetts:** Quail reared in captivity under permit may be exported. Game may be reared in captivity under license (no fee) and sold for propagation under regulations of commissioners; deer, elk, pheasants, quail, European or gray partridge, and wild fowl may be reared in captivity under license (no fee) and sold for food when properly tagged. Tag fee, 5 cents. Licensed dealers may sell such game.
- Michigan:** Deer, elk, pheasants, and wild ducks may be raised in captivity under \$5 license and sold at any time for breeding or stocking purposes and the carcasses transported or sold for food when properly tagged (tags, 5 cents each). Ducks killed by shooting²¹ (except under direct supervision of a deputy warden) may not be sold or disposed of. Licensed retail dealer, club, hotel, restaurant, etc., may sell portion of tagged game to patron or customer for actual consumption or use without additional license.
- Minnesota:** Game raised in captivity under license (fee, \$1) may be sold alive at any time for propagating purposes, and may be killed, sold, and transported under regulations of commissioner. No fee required to raise game birds for domestic use or as pets.
- Missouri:** Deer, elk, and other protected game raised in captivity under license (fee, \$5) may be transported and sold under regulations of the commissioner.
- Montana:** Game raised in licensed private preserve (fee, \$5) may be killed, sold, or transported at any time. If nucleus stock is captured from wild animals in the State, no such animals nor their progeny shall be sold for a period of three years.
- Nevada:** Game raised in licensed preserve (fee, \$10) may be sold or shipped at any time under invoice.
- New Hampshire:** Game raised in captivity under \$2 license may be sold or transported at any time when properly tagged under regulations of commissioner.
- New Jersey:** Mallard, wood, and black ducks and Canada geese (when raised under Federal permit²¹), English and Mongolian pheasants, quail, ruffed grouse, deer, rabbits, and squirrels raised in licensed preserves (fee, \$5) may be killed at any time, and if properly tagged (tag fee, 5 cents) may be sold for food or exported for sale. Live deer, on payment of \$5 for each animal, and game birds possessed under a breeder's license may be exported for propagation.
- New Mexico:** Game raised in licensed preserve may be exported or sold at any time, under invoice, if the number of animals or birds in the park at the time the license is secured is not thereby reduced.
- New York:** Elk, white-tailed deer, European red deer, fallow deer, Japanese deer, roebuck, pheasants, Canada geese, Hutchins geese, mallard, and black ducks raised in captivity under license may be sold for breeding purposes and may be killed, sold, or exported at any time under license when properly tagged. Said ducks and geese may be killed by shooting during open season only, but ducks and geese²¹ killed by shooting may not be sold, except under regulations of commission. Varying hares and cottontail rabbits bred in captivity under \$5 license may be sold for food during close season, when properly tagged, under rules and regulations of the conservation department.
- North Carolina:** Several counties have laws in regard to game raised in captivity.
- North Dakota:** Board may issue permits to breed or domesticate game.
- Ohio:** Ringneck, Mongolian, or Chinese pheasants and mallard and black ducks raised in captivity under a breeder's license (fee, \$5), may be sold for propagation and may be killed and sold when duly tagged. No pheasant, mallard, or black duck raised in domestication shall be killed by shooting except during the open season, and no mallard or black duck killed by shooting shall be bought or sold unless it shall have had a well-defined V-shaped section removed from the web of one foot before it attains the

²¹ Michigan, New Jersey, and New York: See Federal Regulation, 8, p. 73.

Ohio—Continued.

age of four weeks. Packages must be labeled to show the number and kinds of birds contained therein, together with the name and address of the consignor.

Deer, squirrels, and rabbits may be possessed in inclosures as pets.

Oklahoma: Game raised under license (fee, \$2) may be transported for propagation at any time, and for food, when properly tagged, during season prescribed by commissioner.

Oregon: Game birds and animals raised in captivity under permit (fee, \$2), may be exported or sold at any time upon being properly tagged by commissioner or deputy. Tag fee, 5 cents each. Written permit from commissioner must be attached to each shipment. Packages containing game to be plainly labeled.

Pennsylvania: Game breeder's certificate, fee \$1, bond \$500. Game raised in captivity may be sold alive or dead within the State.

Rhode Island: Game raised in captivity under permit may be sold if alive at any time for propagation, under regulations of commissioners.

South Carolina: Any birds or animals protected by law may be kept in possession for purposes of propagation or domestication.

South Dakota: Game raised in captivity may be exported or sold under written permission of State game warden.

Utah: Game raised in licensed private preserves (fee, \$25) may be sold when duly tagged. Fifty birds and ten animals of each kind may be captured, under permit of commissioner, for propagating purposes.

Vermont: Game raised in licensed private preserves (fee, \$2) may be exported at any time when duly marked and tagged, and may be sold for propagation at any time, or for food, under tag in accordance with regulations of commissioner.

Virginia: Game animals and birds raised under breeder's license (fee, \$25) may be disposed of at any time for propagating or other purposes. Packages containing animals or birds transported for propagating purposes must be marked to show clearly the names of consignor and consignee and that they are being transported for propagating purposes. Carcasses of game animals or birds must be tagged (fees, smaller birds and animals, 2 cents; wild turkeys, 10 cents; deer, bear, or elk, 50 cents). Proprietor of hotel or restaurant or a dealer may sell under a \$5 license to guests or patrons game raised in captivity. (No license required of keeper of hotel or restaurant or a dealer to sell, during open season, waterfowl and rabbits raised in captivity or other species of propagated game the sale of which is not prohibited.)

Holder of a game breeder's license, under permit and regulations of the commissioner, may trap wild animals or birds for breeding purposes, but the animals or birds so taken shall not be sold or otherwise disposed of.

Washington: Game and fur-bearing animals and wild birds may be raised in captivity under license (fee, \$10) and sold and transported for food or propagating purposes when properly tagged. Keeper of hotel, restaurant, boarding house, or club, and retail dealer in meats, when duly licensed (fee, \$5), may sell carcasses or parts thereof when properly tagged. Under proper permit from State game warden, animals and birds may be captured on State game preserves or imported from another State or country for propagating purposes.

West Virginia: The owner of elk kept in inclosure may kill them at any time, and may pursue and recapture, by killing or otherwise, elk which have escaped from his inclosure. Tame deer may be killed by the owner.

Wisconsin: Under permit and supervision of the commission wild animals may be taken and transported for propagation within the State.

Wyoming: Natural increase of big game (except moose) captured under permit (fee, \$1) and held for propagation may be exported or sold.

NEW LAWS PASSED IN 1920.

[For correct seasons for hunting migratory birds and other game see "Summary of Laws Relating to Seasons, Licenses, etc.," pp. 8-52.]

Federal.—Two acts: Prohibiting sale in the District of Columbia of quail, grouse, partridge, ptarmigan, prairie chicken, pheasant, wild turkey, and marsh blackbird, except, under regulations of the Commissioners of the District of Columbia, live birds for propagating purposes (Public, No. 101, 66th Cong.); authorizing the Secretary of the Interior to determine and open up for entry lands which are chiefly valuable for agriculture in the Klamath Lake Bird Refuge, Oregon (Public, No. 226, 66th Cong.).

Georgia.—Laws not received.

Kentucky.—One act: Lengthening the season two months on doves, thus making the State and Federal seasons uniform; prescribing, after a close season for several years, an open season on woodcock from November 15 to December 31 (however, the Federal season is from October 1 to November 30, inclusive; so that woodcock may be hunted only from November 15 to November 30, inclusive, without violating either Federal or State laws); fixing seasons on wild ducks, geese, and Wilson snipe or jacksnipe in substantial conformity with the Federal regulations; prescribing uniform bag limits on wild fowl, jacksnipe, woodcock, rails, coots, and gallinules; prohibiting the taking of game with a gun larger than No. 10 gauge or by the aid of an airplane, power boat, sailboat, boat under sail, or at night from sunset to one-half hour before sunrise; and extending until 1924 close terms throughout the year on wild turkey, imported pheasant, and Hungarian partridge; and until 1925 on deer and elk (S. 243).

Louisiana.—One act: Making the open season on squirrels October 1 to March 1 instead of September 15 to February 15; making November 15 to February 15 the open season on quail and turkeys hens and November 15 to March 15 on gobblers, thus shortening the season two weeks on quail and gobblers and six weeks on turkey hens; prohibiting shooting of all game between sunset and half an hour before sunrise, and making the dove season October 16 to January 31 instead of September 16 to December 31, thus conforming these two provisions to the Federal regulations; prohibiting the sale of wild ducks and all other game except squirrels and rabbits (No. 136).

Maryland.—Eleven acts: Repealing all local seasons on upland game, and prescribing November 10 to January 1 as a uniform open season throughout the State on rabbit, squirrel, quail, ruffed grouse, male introduced pheasant, and wild turkey, lengthening the season one week on woodcock; prohibiting all sale of quail, ruffed grouse, introduced pheasant, and wild turkey, whether taken within or without the State, except live birds for propagating purposes; and prohibiting the killing of introduced pheasant hens, but allowing those raised in captivity to be killed during the open season by means other than shooting (S. 134); increasing the salary of the State game warden from \$1,800 to \$2,500 per annum, and repealing the provision limiting his expenses to \$500 per annum; adding muskrat, otter, and mink to list of animals specifically defined as game; authorizing appointment of deputy game wardens with police power throughout the State or such counties or cities as the conservation commission may designate, in lieu of county and local wardens; authorizing tags to be issued with licenses; requiring a hunting license to trap or kill protected fur animals; repealing provision requiring written permission to hunt on land of another, the provision prohibiting aliens from hunting or possessing firearms, the provision requiring the conservation commission to make equitable distribution of the State game protection fund in proportion to the amounts contributed to said fund by the respective counties, and the provision directing that net receipts from fines for violation of the hunting license law be paid into the State game protection fund (H. 193); authorizing the conservation commission to issue permits to their employees to trap game birds or animals on State lands or lands controlled by the State game department for restocking in the State (S. 244); making it unlawful to trespass upon or interfere with the management of any game preserve without consent of the owner (H. 287); prohibiting trespass upon posted lands, but providing that prosecution shall only be instituted by landowner or tenant; prescribing a penalty of \$100 for unauthorized entry or trespass upon lands or waters owned or controlled by the State for the use of the game and fish departments or as game preserves or refuges (H. 194); removing protection from turkey buzzards (H. 754); prohibiting hunting in Allegany, Garrett, and Washington Counties when the ground is covered

with snow (H. 452) ; repealing the local act of 1916 protecting quail in Frederick County until 1921 (S. 32) ; prescribing a license (fee, \$5.25) for blinds on the Patuxent River and tributaries, except in the waters of St. Marys County, making it unlawful to shoot from any licensed blind without consent of licensee, and prohibiting the erecting or placing of a blind within 300 yards of another licensed blind, the distance to be measured by shore line if blind is on the shore, and by air line if erected in the water (S. 217) ; permitting the shooting of wild fowl from blinds and sinkboxes on the Potomac River in Charles and Prince George Counties, but making it unlawful to have a blind more than 300 yards from the shore in said counties (H. 517) ; prescribing a \$5 license for blinds and sinkboxes in Talbot County and limiting the issuance of such licenses to residents of the county ; prohibiting the placing of blinds or sinkboxes more than 200 yards from natural shore at mean low-water mark or less than 400 yards distant from each other, measuring in a straight line in any direction, in the waters of Dickinsons Bay and Reeds Creek (elsewhere in county blinds or sinkboxes may not be placed more than 100 yards from the natural shore at mean low-water mark, or within 500 yards of another blind or sinkbox) ; requiring display of license numbers on all blinds and sinkboxes, and making it unlawful to use or shoot from the blind or sinkbox of another without consent of owner (H. 238) ; prohibiting the hunting or shooting of ducks on Wicomico River and tributaries, St. Marys County, except on Tuesdays, Thursdays, and Saturdays, and the placing or using of a blind more than 125 yards from the shore of said waters, or within 400 yards of any other blind, and allowing only citizens of the county to maintain blinds ; making it unlawful to have a motorboat or houseboat at anchor or adrift on the feeding grounds of ducks (S. 114).

Massachusetts.—Five acts: Prohibiting possession of nongame birds except under scientific permit (ch. 208) ; permitting use of live geese as decoys in Nantucket County (ch. 273) ; authorizing retirement of fish and game wardens when disabled in line of duty (ch. 304) ; shortening the season one month on hares and rabbits by closing January 31 instead of February 28, but prohibiting the taking of hares in Barnstable, Dukes, and Nantucket Counties until 1923, prescribing bag limits of 2 hares and 5 rabbits a day, and prohibiting sale of hares, except those imported from States which permit their sale (ch. 425) ; prescribing a fee (25 cents) for licenses to minors to trap quadrupeds, fixing a minimum age (12 years) at which they may be issued, and requiring that applicants must be citizens of the United States (ch. 300).

Mississippi.—No game legislation.

New Jersey.—Seven acts: Making State laws on migratory birds uniform with Federal regulations ; permitting all game to be possessed during open season and first 10 days of close season ; adding squirrels, quail, ruffed grouse, and Canada geese raised in preserves to the list of game that may be sold for food purposes or exported when properly tagged ; permitting Belgian hares and jack rabbits legally killed to be brought into the State at any time for sale and consumption ; strengthening the export law so as to prohibit the export of reedbirds, plovers, yellowlegs, Wilson snipe, and rails by a resident, but permitting a nonresident licensee to export two days' limit of game a calendar week, in lieu of 10 rabbits, 50 rail, 50 reedbirds, and 15 in the aggregate of all other birds a season (ch. 31) ; making it unlawful to remove the skin or feathers, mutilate the body, or otherwise destroy the identity or sex of any wild bird or animal in the field for purpose of concealing its identity (S. 44) ; authorizing the board of fish and game commissioners to lease, from incorporated bodies, tracts of not less than 40 acres of land to be operated in connection with the State game farm, limiting expenditures on each tract to \$2,500 per annum and requiring 75 per cent of the game birds and animals raised on such tracts to be

liberated in the county in which raised (A. 132); protecting ringneck pheasants for five years in Chester, Cinnaminson, and Delran Townships of Burlington County, and Pensauken Township, Camden County (A. 231); extending to Christmas the open season on deer instead of closing it with December 20; repealing the provisions requiring the board of fish and game commissioners to investigate complaints of damage by deer on cultivated lands and to issue special permits authorizing the killing of deer doing damage; permitting the owners, lessees, and their authorized agents to kill deer at any time on their own cultivated land, and defining cultivated land to mean pasture fields seeded with cultivated grass, or land on which planted crops are growing (A. 464); extending the act authorizing farmers and fruit growers to protect crops from damages by rabbits or hares to include the shooting of rabbits, adding trees, shrubbery, and nursery stock to the property which is protected, providing that permits may be issued to authorized representatives of farmers and fruit growers, and requiring the person so shooting rabbits to report the number killed to the county game warden within 48 hours (A. 516); standardizing the salaries of wardens in accordance with the general provisions of law relating to State officers under civil service (A. 44).

New York.—Fourteen acts: Including Japanese deer in the list of animals for which a license is necessary for raising in game preserves (ch. 61); including Canada and Hutchins geese raised in preserves in the list of game which may be imported into the State when properly tagged (ch. 68); adding the crow blackbird to the list of birds the nests and eggs of which are unprotected (ch. 69); empowering the conservation commission to issue permits for taking gray, black, or fox squirrels within the corporate limits of any city or village (ch. 70); repealing the provision providing that when an open season commences or ends on Sunday it shall be deemed to commence or end on the preceding Saturday (ch. 72); repealing the provision authorizing the payment of half of the fines to special game protectors in actions brought upon information furnished by them (ch. 97); repealing the provision requiring the chief game protector to furnish bond, but requiring the deputy chief game protector and each inspector to furnish bond in the sum of \$1,000 for faithful performance of duties (ch. 182); including Reeves and Flanders Bays at the west end of Great Peconic Bay, Long Island, in the list of waters on which waterfowl may be taken by aid of any floating device other than sailboats or power boats at any distance from shore; and providing that on the Hudson River, and on lakes, ponds, and streams, or parts thereof, in counties bordering on or through which the Hudson passes, waterfowl may be taken by aid of any floating device other than sailboats, power boats, or batteries at any distance from shore (ch. 218); making it unlawful to post lands or waters unless the ownership or right to the possession and control of same, by lease or otherwise, is evidenced at the time of such posting by an instrument in writing (ch. 455); extending the close term on quail throughout the State, except Long Island, until 1925; prescribing October 15 to November 15 as the open season on ruffed grouse or partridge instead of October 1 to November 30, and reducing bag limits from 4 to 2 a day and from 20 to 10 a season (ch. 462); authorizing the commissioner to make regulations governing the sale of game which was raised in captivity and imported under license for food, breeding, or stocking purposes (ch. 466); increasing the clerk fee from 10 to 25 cents for issuing resident hunting and trapping licenses (ch. 468); reenacting the buck law, repealed in 1919, and limiting a hunter to one buck a season; shortening the season two weeks on deer in the Adirondack region by opening October 15 instead of October 1; extending the open season (November 1 to November 15) on deer throughout Orange and Sullivan Counties, opening Delaware County

to deer hunting during first half of November, permitting general hunting in Rensselaer County in lieu of the provision allowing landowners or tenants to take deer on their own land during open season, and closing Columbia County to deer hunting (ch. 520); providing that civil-service examinations for protectors of all grades shall be confined to counties (ch. 549); increasing traveling expenses of game protectors from \$600 to \$900 and of inspectors from \$750 to \$1,200 a year (ch. —).

Ohio.—One act: Lengthening the season five days on squirrels and making the open season September 15 to October 20 instead of August 20 to September 20.

Rhode Island.—Laws not received.

South Carolina.—Six acts: Prescribing November 25 to March 1 the open season for quail instead of November 15 to February 15 and shortening the season on wild turkeys six weeks and making it uniform with the season on quail; changing the open season on doves to conform to the Federal regulations; increasing the maximum penalty for violation of the act from \$25 to \$100 (No. —); providing that the chief game warden shall be elected by the general assembly and commissioned by the governor, and that he may be removed for cause by the governor; repealing the provisions authorizing the Audubon Society to nominate and recommend to the governor the names of suitable persons for positions of chief game warden and fish and game wardens (No. —); authorizing the issue of scientific collecting permits by the chief game warden instead of the secretary of state (No. —); permitting shipment within the State for private use, of not more than two days' limit of game in one calendar week under tag and regulations of chief game warden (No. —); prohibiting the killing of does for a period of 5 years (No. —); providing that nine-twentieths of the license fees collected in each county shall be returned to the county school fund at the end of each year, thus restoring in modified form a provision repealed in 1919 (No. —).

Virginia.— — acts: Lengthening the open season one month on deer and fixing the dates between October 1 and February 1; opening the season on elk except in national forest areas during the last half of December, and limiting a hunter to one elk a season; prescribing an open season on squirrels from August 15 to February 1, except in 16 counties having local laws; prescribing bag limits of 15 quail, 6 ruffed grouse (pheasants), and 2 wild turkeys a day; amending and strengthening the dog law, authorizing the transfer of 15 per cent of the gross receipts from the sale of dog licenses to the department of game and inland fisheries for expenses of enforcing the act, including a salary allowance of \$900 a year to the commissioner of game and inland fisheries.

Dominion legislation.—Two orders in council: Modifying seasons on migratory game birds in certain sections of British Columbia; making the open season on waterfowl and rails in New Brunswick September 15 to December 31, instead of September 1 to December 14, and on woodcock and Wilson snipe in Nova Scotia, September 15 to November 30, instead of September 1 to December 14, and repealing the special season from August 15 to November 30 on shorebirds in the four northeastern counties of Quebec which border on the Gulf of St. Lawrence and the St. Lawrence River; prohibiting sale of migratory game birds in British Columbia, Manitoba, New Brunswick, Ontario, and Saskatchewan; fixing daily bag limits on migratory game birds in the various Provinces and prescribing seasonal limits of 200 on ducks in Alberta and Ontario, 250 ducks and 50 geese in British Columbia, 250 ducks in Manitoba, and 250 waterfowl in Saskatchewan; prohibiting the taking of migratory game birds by use of a gun larger than No. 10 gauge or by any automatic, swivel, or machine gun or

battery, by any airplane, power boat, sailboat, or sunken boat, from any vehicle, or from sunset to sunrise; prescribing detailed regulations governing the taking of migratory birds for propagating purposes, permitting birds raised in captivity to be killed, except by shooting, and when so killed to be sold when properly tagged; requiring holders of scientific and propagating permits to make an annual report of operations; prescribing a special taxidermist permit; requiring shipments of migratory birds for scientific or propagating purposes, made by mail or otherwise, to be marked with the number of the permit, the name and address of the shipper, and an accurate statement of the contents (P. C. 997); authorizing the leasing of South Baffin Land for propagating reindeer and musk-oxen (P. C. —).

Alberta.—One act: Shortening the season on grouse, partridge, prairie chicken, and ptarmigan one month, making it October 15 to October 31; extending the close term on Hungarian pheasant until 1925; prescribing a \$5 taxidermist license (ch. 37).

British Columbia.—One act, amending the game act generally: Extending the protected area in Victoria Harbor in which all hunting is prohibited to include Selkirk Water, Victoria Arm, and Portage Inlet; prohibiting hunting or carrying firearms in game preserves except under permit; repealing the provision allowing the lieutenant governor in council to prescribe open seasons for killing western and American robins and thrushes; repealing the bag limit of 250 ducks a season; prohibiting the placing of poisoned baits for game or fur animals, except to protect one's own stock; requiring shipments of big game or fur-bearing animals or parts thereof to be plainly marked to show contents and names and addresses of consignor and consignee, and to be prepared so as to be easily inspected; requiring licensee to sign his license, to have it in possession when carrying firearms, and to exhibit it upon request of game warden or constable; repealing the provision requiring a licensee to wear badge; repealing the special \$50 nonresident game-bird license; prohibiting the carrying of a loaded gun in any vehicle or railway car; increasing from 16 to 18 the age of boys to whom the issuance of licenses to carry firearms is prohibited without written consent of parents or guardians; requiring guide to prevent person for whom he is acting as guide from violating game laws and to report violations to nearest game warden; permitting game to be kept in cold storage during open season under permit; extending the provision authorizing the establishment of game preserves on crown lands to include water areas and marsh and other lands; authorizing the game-conservation board to appoint a secretary who shall, under direction of the chairman, have charge of the office of the board and providing that his salary shall be fixed by the lieutenant governor in council; requiring the board to make an annual report to the minister (bill No. 12).

Manitoba.—One act: Permitting a hunter to take one bull elk in 1920, the first open season on elk since 1916, and shortening the open season 11 days on big game by making the period December 1 to December 10 instead of November 20 to December 10; providing an open season of one week, from October 15 to October 22, on prairie chicken, partridge, and grouse, and permitting them to be possessed during the first 10 days of closed season; requiring holder of resident bird license, on or before December 15, to return license with sworn statement that he has not violated the game laws; permitting ducks legally killed to be possessed during first four months of closed season (bill No. 27).

New Brunswick.—One act: Increasing fee for nonresident license to hunt birds from \$10 to \$15, and for license to deal in hides of big game, nonresident or alien, from \$25 to \$50, and resident from \$2 to \$10; prohibiting the carrying of rifles in the woods during open season by a person not hold-

ing a hunting license; prescribing penalties for officers issuing hunting licenses who fail to administer required oaths to applicants; providing separate shipping coupons for the head, hide, and carcass of big game, and increasing penalties for violations concerning big game.

Nova Scotia.—One act: Shortening the season two weeks on moose by closing November 16 instead of December 1; extending the close term on ruffed grouse (birch partridge) until 1922; increasing penalties for violations of the game act (H. B. 150).

Northwest Territories.—Two orders in council: Prohibiting hunting on Banks Island (P. C. 533); authorizing minister to remit hunting or trapping license fees to members of the Royal Canadian Mounted Police and officers of the Dominion parks branch when on duty in the Northwest territories (P. C. 611).

Ontario.—One order in council: Lengthening the season six weeks on deer north of the Canadian Government Railway by making it October 1 to November 30 instead of November 5 to November 20.

Quebec.— — acts: Shortening the season 19 days on deer and bull moose and 50 days on caribou; fixing a uniform season from September 20 to December 31 throughout the Province on big game, except on deer and bull moose in Pontiac and Temiscaming Counties, where the season was made to open September 10 instead of October 1; abolishing the local season on deer and bull moose in Labelle and Ottawa Counties, thus leaving the general season in effect in these counties; abolishing the special season, opening August 15, on shore-birds in Bonaventure, Gaspé, Rimouski, and Saguenay Counties, thus making the season September 1 to December 14 uniform throughout the Province.

Saskatchewan.—One act: Requiring persons who accidentally or otherwise unlawfully kill females of big game, other than caribou, and fawns thereof to dress and immediately deliver the meat and hide of such animal to the agent of the nearest railway and report such killing and delivery to the chief game guardian; providing a two weeks' open season during the last half of October and a bag limit of 6 a day and 30 a season on prairie chicken (sharp-tailed or pinnated grouse); requiring a licensee to sign his license (ch. 50).

Yukon.—One act: Lengthening the season one month on big game by opening August 1 instead of September 1; prescribing licenses for guides and camp helpers; permitting resident under a special license (fee, \$25) to kill and sell at any time for food purposes male moose and male caribou over one year of age, and requiring dealer to obtain a license (fee, \$10) to sell moose or caribou; permitting nonresident licensee to export under certificate of game guardian trophies, including head, hide, and hoofs, of big game lawfully killed by him (ch. 1).

LACEY ACT, REGULATING INTERSTATE COMMERCE IN GAME.

Federal laws affecting the shipment of game comprise statutes regulating interstate commerce in game and the importation of birds and mammals from foreign countries, as follows:

CRIMINAL CODE—ACT OF MARCH 4, 1909.

[35 Stat., 1137.]

SEC. 241. The importation into the United States, or any Territory or District thereof, of the mongoose, the so-called "flying foxes," or fruit bats, the English sparrow, the starling, and such other birds and animals as the Secretary of Agriculture may from time to time declare to be injurious to the interests of

agriculture or horticulture, is hereby prohibited; and all such birds and animals shall, upon arrival at any port of the United States, be destroyed or returned at the expense of the owner. No person shall import into the United States or into any Territory or District thereof any foreign wild animal or bird, except under special permit from the Secretary of Agriculture: *Provided*, That nothing in this section shall restrict the importation of natural-history specimens for museums or scientific collections, or of certain cage birds, such as domesticated canaries, parrots, or such other birds as the Secretary of Agriculture may designate. The Secretary of the Treasury is hereby authorized to make regulations for carrying into effect the provisions of this section.

SEC. 242. It shall be unlawful for any person to deliver to any common carrier for transportation, or for any common carrier to transport from any State, Territory, or District of the United States to any other State, Territory, or District thereof, any foreign animals or birds the importation of which is prohibited, or the dead bodies or parts thereof of any wild animals or birds, where such animals or birds have been killed or shipped in violation of the laws of the State, Territory, or District in which the same were killed, or from which they were shipped: *Provided*, That nothing herein shall prevent the transportation of any dead birds or animals killed during the season when the same may be lawfully captured, and the export of which is not prohibited by law in the State, Territory, or District in which the same are captured or killed: *Provided further*, That nothing herein shall prevent the importation, transportation, or sale of birds or bird plumage manufactured from the feathers of barnyard fowls.

SEC. 243. All packages containing the dead bodies, or the plumage, or parts thereof, of game animals, or game or other wild birds, when shipped in interstate or foreign commerce, shall be plainly and clearly marked, so that the name and address of the shipper, and the nature of the contents, may be readily ascertained on an inspection of the outside of such package.

SEC. 244. For each evasion or violation of any provision of the three sections last preceding, the shipper shall be fined not more than \$200; the consignee knowingly receiving such articles so shipped and transported in violation of said sections shall be fined not more than \$200; and the carrier knowingly carrying or transporting the same in violation of said sections shall be fined not more than \$200.

SECTIONS 1 AND 5—ACT OF MAY 25, 1900.⁶²

[31 Stat., 187-8.]

That the duties and powers of the Department of Agriculture are hereby enlarged so as to include the preservation, distribution, introduction, and restoration of game birds and other wild birds. The Secretary of Agriculture is hereby authorized to adopt such measures as may be necessary to carry out the purposes of this act and to purchase such game birds and other wild birds as may be required therefor, subject, however, to the laws of the various States and Territories. The object and purpose of this act is to aid in the restoration of such birds in those parts of the United States adapted thereto where the same have become scarce or extinct, and also to regulate the introduction of American or foreign birds or animals in localities where they have not heretofore existed.

⁶² Secs. 2, 3, and 4 superseded by secs. 241-244 of the Criminal Code, act of Mar. 4, 1909 (35 Stat., 1137).

The Secretary of Agriculture shall from time to time collect and publish useful information as to the propagation, uses, and preservation of such birds.

And the Secretary of Agriculture shall make and publish all needful rules and regulations for carrying out the purposes of this act, and shall expend for said purposes such sums as Congress may appropriate therefor.

SEC. 5. That all dead bodies, or parts thereof, of any foreign game animals, or game or song birds, the importation of which is prohibited, or the dead bodies, or parts thereof, of any wild game animals, or game or song birds transported into any State or Territory, or remaining therein for use, consumption, sale, or storage therein, shall upon arrival in such State or Territory be subject to the operation and effect of the laws of such State or Territory enacted in the exercise of its police powers, to the same extent and in the same manner as though such animals or birds had been produced in such State or Territory, and shall not be exempt therefrom by reason of being introduced therein in original packages or otherwise. This act shall not prevent the importation, transportation, or sale of birds or bird plumage manufactured from the feathers of barnyard fowl.

TARIFF ACT PROHIBITING IMPORTATION OF PLUMAGE.

ACT OF OCTOBER 3, 1913.

[38 Stat., 148.]

PAR. 347. Feathers and downs, on the skin or otherwise, crude or not dressed, colored, or otherwise advanced or manufactured in any manner, not specially provided for in this section, twenty per centum ad valorem; when dressed, colored, or otherwise advanced or manufactured in any manner, and not suitable for use as millinery ornaments, including quilts of down and manufactures of down, forty per centum ad valorem; artificial or ornamental feathers suitable for use as millinery ornaments, artificial and ornamental fruits, grains, leaves, flowers, and stems or parts thereof, of whatever material composed, not specially provided for in this section, sixty per centum ad valorem; boas, boutonnières, wreaths, and all articles not specially provided for in this section, composed wholly or in chief value of any of the feathers, flowers, leaves, or other material herein mentioned, sixty per centum ad valorem: *Provided*, That the importation of aigrettes, egret plumes or so-called osprey plumes, and the feathers, quills, heads, wings, tails, skins, or parts of skins, of wild birds, either raw or manufactured, and not for scientific or educational purposes, is hereby prohibited; but this provision shall not apply to the feathers or plumes of ostriches or to the feathers or plumes of domestic fowls of any kind.

LAW PROTECTING BIRDS AND THEIR EGGS ON FEDERAL BIRD RESERVATIONS.

ACT OF MARCH 4, 1909.

[35 Stat., 1104.]

SEC. 84. Whoever shall hunt, trap, capture, willfully disturb, or kill any bird of any kind whatever, or take the eggs of any such bird, on any lands of the United States which have been set apart or reserved as breeding grounds for birds, by any law, proclamation, or Executive order, except under such rules and regulations as the Secretary of Agriculture may, from time to time, prescribe, shall be fined not more than \$500, or imprisoned not more than six months, or both.

months as the High Contracting Powers may severally deem appropriate and define by law or regulation.

2. The close season on migratory insectivorous birds shall continue throughout the year.

3. The close season on other migratory nongame birds shall continue throughout the year, except that Eskimos and Indians may take at any season auks, auklets, guillemots, murres and puffins, and their eggs, for food and their skins for clothing, but the birds and eggs so taken shall not be sold or offered for sale.

ARTICLE III.

The High Contracting Powers agree that during the period of ten years next following the going into effect of this Convention, there shall be a continuous close season on the following migratory game birds, to wit:—

Band-tailed pigeons, little brown, sandhill and whooping cranes, swans, curlew and all shorebirds (except the black-breasted and golden plover, Wilson or jack snipe, woodcock, and the greater and lesser yellowlegs); provided that during such ten years the close seasons on cranes, swans and curlew in the Province of British Columbia shall be made by the proper authorities of that Province within the general dates and limitations elsewhere prescribed in this convention for the respective groups to which these birds belong.

ARTICLE IV.

The High Contracting Powers agree that special protection shall be given the wood duck and the elder duck either (1) by a close season extending over a period of at least five years, or (2) by the establishment of refuges, or (3) by such other regulations as may be deemed appropriate.

ARTICLE V.

The taking of nests or eggs of migratory game or insectivorous or nongame birds shall be prohibited, except for scientific or propagating purposes, under such laws or regulations as the High Contracting Powers may severally deem appropriate.

ARTICLE VI.

The High Contracting Powers agree that the shipment or export of migratory birds or their eggs from any State or Province, during the continuance of the close season in such State or Province, shall be prohibited except for scientific or propagating purposes, and the international traffic in any birds or eggs at such time captured, killed, taken, or shipped at any time contrary to the laws of the State or Province in which the same were captured, killed, taken, or shipped shall be likewise prohibited. Every package containing migratory birds or any parts thereof or any eggs of migratory birds transported, or offered for transportation from the United States into the Dominion of Canada or from the Dominion of Canada into the United States, shall have the name and address of the shipper and an accurate statement of the contents clearly marked on the outside of such package.

ARTICLE VII.

Permits to kill any of the above-named birds which, under extraordinary conditions, may become seriously injurious to the agricultural or other interests in any particular community, may be issued by the proper authorities of the

High Contracting Powers under suitable regulations prescribed therefor by them respectively, but such permits shall lapse, or may be canceled, at any time when, in the opinion of said authorities, the particular exigency has passed, and no birds killed under this article shall be shipped, sold, or offered for sale.

ARTICLE VII.

The High Contracting Powers agree themselves to take, or propose to their respective appropriate law-making bodies, the necessary measures for insuring the execution of the present Convention.

ARTICLE IX.

The present Convention shall be ratified by the President of the United States of America, by and with the advice and consent of the Senate thereof, and by His Britannic Majesty. The ratifications shall be exchanged at Washington as soon as possible and the Convention shall take effect on the date of the exchange of the ratifications. It shall remain in force for fifteen years, and in the event of neither of the High Contracting Powers having given notification, twelve months before the expiration of said period of fifteen years, of its intention of terminating its operation, the Convention shall continue to remain in force for one year and so on from year to year.

In faith whereof the respective Plenipotentiaries have signed the present Convention in duplicate and have hereunto affixed their seals.

Done at Washington this sixteenth day of August, one thousand nine hundred and sixteen.

[SEAL.]

ROBERT LANSING.

[SEAL.]

CECIL SPRING RICE.

And whereas the said Convention has been duly ratified on both parts, and the ratification of the two Governments were exchanged in the City of Washington, on the seventh day of December, one thousand nine hundred and sixteen;

Now, therefore, be it known that I, Woodrow Wilson, President of the United States of America, have caused the said Convention to be made public, to the end that the same and every article and clause thereof may be observed and fulfilled with good faith by the United States and the citizens thereof.

In testimony whereof I have hereunto set my hand and caused the seal of the United States to be affixed.

Done at the City of Washington this eighth day of December in the year of our Lord one thousand nine hundred and sixteen, and of the Independence of the United States of America the one hundred and forty-first.

WOODROW WILSON.

By the President:

ROBERT LANSING,

Secretary of State.

MIGRATORY BIRD TREATY ACT.*

[Approved July 3, 1918. 40 Stat., 755.]

AN ACT To give effect to the convention between the United States and Great Britain for the protection of migratory birds concluded at Washington, August sixteenth, nineteen hundred and sixteen, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this act shall be known by the short title of the "Migratory Bird Treaty Act."

SEC. 2. That unless and except as permitted by regulations made as herein-after provided, it shall be unlawful to hunt, take, capture, kill, attempt to take, capture or kill, possess, offer for sale, sell, offer to purchase, purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported, carry or cause to be carried by any means whatever, receive for shipment, transportation or carriage, or export, at any time or in any manner, any migratory bird, included in the terms of the convention between the United States and Great Britain for the protection of migratory birds concluded August sixteenth, nineteen hundred and sixteen, or any part, nest, or egg of any such bird.

SEC. 3. That subject to the provisions and in order to carry out the purposes of the convention, the Secretary of Agriculture is authorized and directed, from time to time, having due regard to the zones of temperature and to the distribution, abundance, economic value, breeding habits, and times and lines of migratory flight of such birds, to determine when, to what extent, if at all, and by what means, it is compatible with the terms of the convention to allow hunting, taking, capture, killing, possession, sale, purchase, shipment, transportation, carriage, or export of any such bird, or any part, nest, or egg thereof, and to adopt suitable regulations permitting and governing the same, in accordance with such determinations, which regulations shall become effective when approved by the President.

SEC. 4. That it shall be unlawful to ship, transport, or carry, by any means whatever, from one State, Territory, or District to or through another State, Territory, or District, or to or through a foreign country, any bird, or any part, nest, or egg thereof, captured, killed, taken, shipped, transported, or carried at any time contrary to the laws of the State, Territory, or District in which it was captured, killed, or taken, or from which it was shipped, transported, or carried. It shall be unlawful to import any bird, or any part, nest, or egg thereof, captured, killed, taken, shipped, transported, or carried contrary to the laws of any Province of the Dominion of Canada in which the same was captured, killed, or taken, or from which it was shipped, transported, or carried.

SEC. 5. That any employee of the Department of Agriculture authorized by the Secretary of Agriculture to enforce the provisions of this act shall have power, without warrant, to arrest any person committing a violation of this act in his presence or view and to take such person immediately for examination or trial before an officer or court of competent jurisdiction; shall have power to execute any warrant or other process issued by an officer or court of competent jurisdiction for the enforcement of the provisions of this act; and shall have authority, with a search warrant, to search any place. The several judges of the courts established under the laws of the United States, and

* Constitutionality of act sustained by Supreme Court in decision of Apr. 19, 1920, in case of *State of Missouri v. Ray P. Holland*.

United States commissioners may, within their respective jurisdictions, upon proper oath or affirmation showing probable cause, issue warrants in all such cases. All birds, or parts, nests, or eggs thereof, captured, killed, taken, shipped, transported, carried, or possessed contrary to the provisions of this act or of any regulations made pursuant thereto shall, when found, be seized by any such employee, or by any marshal or deputy marshal, and upon conviction of the offender or upon judgment of a court of the United States that the same were captured, killed, taken, shipped, transported, carried, or possessed contrary to the provisions of this act or of any regulation made pursuant thereto, shall be forfeited to the United States and disposed of as directed by the court having jurisdiction.

SEC. 6. That any person, association, partnership, or corporation who shall violate any of the provisions of said convention or of this act, or who shall violate or fail to comply with any regulation made pursuant to this act, shall be deemed guilty of misdemeanor and upon conviction thereof shall be fined not more than \$500 or be imprisoned not more than six months, or both.

SEC. 7. That nothing in this act shall be construed to prevent the several States and Territories from making or enforcing laws or regulations not inconsistent with the provisions of said convention or of this act, or from making or enforcing laws or regulations which shall give further protection to migratory birds, their nests, and eggs, if such laws or regulations do not extend the open seasons for such birds beyond the dates approved by the President in accordance with section three of this act.

SEC. 8. That until the adoption and approval, pursuant to section three of this act, of regulations dealing with migratory birds and their nests and eggs, such migratory birds and their nests and eggs as are intended and used exclusively for scientific or propagating purposes may be taken, captured, killed, possessed, sold, purchased, shipped, and transported for such scientific or propagating purposes if and to the extent not in conflict with the laws of the State, Territory, or District in which they are taken, captured, killed, possessed, sold, or purchased, or in or from which they are shipped or transported if the packages containing the dead bodies or the nests or eggs of such birds when shipped and transported shall be marked on the outside thereof so as accurately and clearly to show the name and address of the shipper and the contents of the package.

SEC. 9. That the unexpended balances of any sums appropriated by the agricultural appropriation acts for the fiscal years nineteen hundred and seventeen and nineteen hundred and eighteen, for enforcing the provisions of the act approved March fourth, nineteen hundred and thirteen, relating to the protection of migratory game and insectivorous birds, are hereby reappropriated and made available until expended for the expenses of carrying into effect the provisions of this act and regulations made pursuant thereto, including the payment of such rent, and the employment of such persons and means, as the Secretary of Agriculture may deem necessary, in the District of Columbia and elsewhere, cooperation with local authorities in the protection of migratory birds, and necessary investigations connected therewith: *Provided*, That no person who is subject to the draft for service in the Army or Navy shall be exempted or excused from such service by reason of his employment under this act.

SEC. 10. That if any clause, sentence, paragraph, or part of this act shall, for any reason, be adjudged by any court of competent jurisdiction to be invalid, such judgment shall not affect, impair, or invalidate the remainder thereof, but shall be confined in its operation to the clause, sentence, paragraph, or part thereof directly involved in the controversy in which such judgment shall have been rendered.

SEC. 11. That all acts or parts of acts inconsistent with the provisions of this act are hereby repealed.

SEC. 12. Nothing in this act shall be construed to prevent the breeding of migratory game birds on farms and preserves and the sale of birds so bred under proper regulation for the purpose of increasing the food supply.

SEC. 13. That this act shall become effective immediately upon its passage and approval.

MIGRATORY-BIRD TREATY ACT REGULATIONS.

[As approved and promulgated by the President, July 31, 1918, and amended October 25, 1918, July 28, 1919, and July 9, 1920.]

REGULATION 1.—DEFINITIONS OF MIGRATORY BIRDS.

Migratory birds, included in the terms of the convention between the United States and Great Britain for the protection of migratory birds, concluded August 16, 1916, are as follows:

1. *Migratory game birds:*

- (a) Anatidae, or waterfowl, including brant, wild ducks, geese, and swans.
- (b) Gruidae, or cranes, including little brown, sandhill, and whooping cranes.
- (c) Rallidae, or rails, including coot, gallinules, and sora and other rails.
- (d) Limicolae, or shorebirds, including avocets, curlews, dowitchers, godwits, knots, oyster catchers, phalaropes, plovers, sandpipers, snipe, stilts, surf birds, turnstones, willet, woodcock, and yellowlegs.
- (e) Columbidae, or pigeons, including doves and wild pigeons.

2. *Migratory insectivorous birds:* Cuckoos; flickers and other woodpeckers; nighthawks or bull-bats and whip-poor-wills; swifts; hummingbirds; flycatchers; bobolinks, meadowlarks, and orioles; grosbeaks; tanagers; martins and other swallows; waxwings; shrikes; vireos; warblers; pipits; catbirds and brown thrashers; wrens; brown creepers; nuthatches; chickadees and titmice; kinglets and gnatcatchers; robins and other thrushes; and all other perching birds which feed entirely or chiefly on insects.

3. *Other migratory nongame birds:* Auks, auklets, bitterns, fulmars, gannets, grebes, gullenots, gulls, herons, jaegers, loons, murre, petrels, puffins, shearwaters, and terns.

[As amended July 9, 1920.]

REGULATION 2.—DEFINITIONS OF TERMS.

For the purposes of these regulations the following terms shall be construed, respectively, to mean—

Secretary.—The Secretary of Agriculture of the United States.

Person.—The plural or the singular, as the case demands, including individuals, associations, partnerships, and corporations, unless the context otherwise requires.

Take.—The pursuit, hunting, capture, or killing of migratory birds in the manner and by the means specifically permitted.

Open season.—The time during which migratory birds may be taken.

Transport.—Shipping, transporting, carrying, exporting, receiving or delivering for shipment, transportation, carriage, or export.

REGULATION 3.—MEANS BY WHICH MIGRATORY GAME BIRDS MAY BE TAKEN.

The migratory game birds specified in Regulation 4 hereof may be taken during the open season with a gun only, not larger than No. 10 gauge, fired from the shoulder, except as specifically permitted by Regulations 7, 8, 9, and 10

hereof; they may be taken during the open season from the land and water, from a blind or floating device (other than an airplane, powerboat, sailboat, any boat under sail, or any floating device towed by powerboat or sailboat), with the aid of a dog, and the use of decoys.

[As amended July 28, 1919.]

REGULATION 4.—OPEN SEASONS ON AND POSSESSION OF CERTAIN MIGRATORY GAME BIRDS.

For the purpose of this regulation, each period of time herein prescribed as an open season shall be construed to include the first and last days thereof.

Waterfowl (except wood duck, eider ducks, and swans), rails, coot, gallinules, black-bellied and golden plovers, greater and lesser yellowlegs, woodcock, Wilson snipe or jacksnipe, and mourning doves may be taken each day from half an hour before sunrise to sunset during the open seasons prescribed therefor in this regulation, by the means and in the numbers permitted by Regulations 3 and 5 hereof, respectively, and when so taken, may be possessed any day in any State, Territory, or District during the period constituting the open season where killed and for an additional period of 10 days next succeeding said open season, but no such birds shall be possessed in a State, Territory, or District at a time when such State, Territory, or District prohibits the possession thereof.

Waterfowl (except wood duck, eider ducks, and swans), coot, gallinules, and Wilson snipe or jacksnipe.—The open seasons for waterfowl (except wood duck, eider ducks, and swans), coot, gallinules, and Wilson snipe or jacksnipe shall be as follows:

In Maine, New Hampshire, Vermont, Massachusetts, New York (except Long Island), Pennsylvania, Ohio, West Virginia, Kentucky, Indiana, Michigan, Wisconsin, Illinois, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas, Colorado, Wyoming, Montana, Idaho, Nevada, and that portion of Oregon and Washington lying east of the summit of the Cascade Mountains the open season shall be from September 16 to December 31;

In Rhode Island, Connecticut, Utah, and that portion of Oregon and Washington lying west of the summit of the Cascade Mountains the open season shall be from October 1 to January 15;

In that portion of New York known as Long Island, and in New Jersey, Delaware, Oklahoma, Texas, New Mexico, Arizona, and California the open season shall be from October 16 to January 31;

In Maryland, the District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Arkansas, and Louisiana the open season shall be from November 1 to January 31; and

In Alaska the open season shall be from September 1 to December 15.

Rails (except coot and gallinules).—The open season for snipe and other rails (except coot and gallinules) shall be from September 1 to November 30, except as follows:

In Louisiana the open season shall be from November 1 to January 31.

Black-bellied and golden plovers and greater and lesser yellowlegs.—The open seasons for black-bellied and golden plovers and greater and lesser yellowlegs shall be as follows:

In Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, and Virginia the open season shall be from August 16 to November 30;

In the District of Columbia, North Carolina, South Carolina, Tennessee, Arkansas, Oklahoma, Texas, New Mexico, Arizona, California, and Alaska the open season shall be from September 1 to December 15;

In Vermont, Pennsylvania, Ohio, West Virginia, Kentucky, Indiana, Michigan, Wisconsin, Illinois, Missouri, Iowa, Minnesota, North Dakota, South Dakota, Nebraska, Kansas, Colorado, Wyoming, Montana, Idaho, Nevada, and that portion of Oregon and Washington lying east of the summit of the Cascade Mountains the open season shall be from September 16 to December 31;

In Utah and in that portion of Oregon and Washington lying west of the summit of the Cascade Mountains the open season shall be from October 1 to January 15; and

In Georgia, Florida, Alabama, Mississippi, and Louisiana the open season shall be from November 1 to January 31.

Woodcock.—The open seasons for woodcock shall be as follows:

In Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Ohio, West Virginia, Kentucky, Indiana, Michigan, Wisconsin, Illinois, Missouri, Iowa, Minnesota, North Dakota, South Dakota, Nebraska, and Kansas the open season shall be from October 1 to November 30; and

In Delaware, Maryland, the District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Arkansas, Louisiana, Texas, and Oklahoma the open season shall be from November 1 to December 31.

Doves.—The open seasons for mourning doves shall be as follows:

In Delaware, Maryland, Virginia, Tennessee, Kentucky, Ohio, Indiana, Illinois, Minnesota, Nebraska, Kansas, Missouri, Arkansas, Oklahoma, Texas, New Mexico, Colorado, Utah, Arizona, California, Nevada, Idaho, and Oregon the open season shall be from September 1 to December 15; and

In North Carolina, South Carolina, Georgia, Florida, Alabama, Louisiana, and Mississippi the open season shall be from October 16 to January 31.

[As amended October 25, 1918, July 28, 1919, and July 9, 1920.]

REGULATION 5.—BAG LIMITS ON CERTAIN MIGRATORY GAME BIRDS.

A person may take in any one day during the open seasons prescribed therefor in Regulation 4 not to exceed the following numbers of migratory game birds:

Ducks (except wood duck and eider ducks).—Twenty-five in the aggregate of all kinds.

Geese.—Eight in the aggregate of all kinds.

Brant.—Eight.

Rails, coot, and gallinules (except sora).—Twenty-five in the aggregate of all kinds.

Sora.—Fifty.

Black-bellied and golden plovers and greater and lesser yellowlegs.—Fifteen in the aggregate of all kinds.

Wilson snipe, or jacksnipe.—Twenty-five.

Woodcock.—Six.

Doves (mourning).—Twenty-five.

[As amended October 25, 1918, and July 28, 1919.]

REGULATION 6.—SHIPMENT, TRANSPORTATION, AND POSSESSION OF CERTAIN MIGRATORY GAME BIRDS.

Waterfowl (except wood duck, elder ducks, and swans), rails, coot, gallinules, black-bellied and golden plovers, greater and lesser yellowlegs, woodcock, Wilson snipe or jacksnipe, and mourning doves and parts thereof legally taken may be transported in or out of the State where taken during the respec-

tive open seasons in that State, and may be imported from Canada during the open season in the Province where taken, in any manner, but not more than the number thereof that may be taken in two days by one person under these regulations shall be transported by one person in one calendar week out of the State where taken; any such migratory game birds or parts thereof in transit during the open season may continue in transit such additional time immediately succeeding such open season, not to exceed five days, necessary to deliver the same to their destination, and may be possessed in any State, Territory, or District during the period constituting the open season where killed, and for an additional period of ten days next succeeding said open season; and any package in which migratory game birds or parts thereof are transported shall have the name and address of the shipper and of the consignee and an accurate statement of the numbers and kinds of birds contained therein clearly and conspicuously marked on the outside thereof; but no such birds shall be transported from any State, Territory, or District to or through another State, Territory, or District, or to or through a Province of the Dominion of Canada contrary to the laws of the State, Territory, or District, or Province of the Dominion of Canada in which they were taken or from which they are transported; nor shall any such birds be transported into any State, Territory, or District from another State, Territory, or District, or from any State, Territory, or District into any Province of the Dominion of Canada at a time when such State, Territory, or District, or Province of the Dominion of Canada prohibits the possession or transportation thereof.

[As amended October 25, 1918, and July 9, 1920.]

REGULATION 7.—TAKING OF CERTAIN MIGRATORY NONGAME BIRDS BY ESKIMOS AND INDIANS IN ALASKA.

In Alaska Eskimos and Indians may take for the use of themselves and their immediate families, in any manner and at any time, and possess and transport auks, auklets, guillemots, murre, and puffins and their eggs for food, and their skins for clothing.

REGULATION 8.—PERMITS TO PROPAGATE AND SELL MIGRATORY WATERFOWL.

1. A person may take in any manner and at any time migratory waterfowl and their eggs for propagating purposes when authorized by a permit issued by the Secretary. Waterfowl and their eggs so taken may be possessed by the permittee and may be sold and transported by him for propagating purposes to any person holding a permit issued by the Secretary in accordance with the provisions of this regulation.

2. A person authorized by a permit issued by the Secretary may possess, buy, sell, and transport migratory waterfowl and their increase and eggs in any manner and at any time for propagating purposes; and migratory waterfowl, except the birds taken under paragraph 1 of this regulation, so possessed may be killed by him at any time, in any manner, except that they may be killed by shooting only during the open season for waterfowl in the State where killed, and the carcasses, with heads and feet attached thereto, of the birds so killed may be sold and transported by him in any manner and at any time to any person for actual consumption, or to the keeper of a hotel, restaurant, or boarding house, retail dealer in meat or game, or a club, for sale or service to their patrons, who may possess such carcasses for actual consumption without a permit, but no migratory waterfowl killed by shooting shall be bought or sold unless each bird before attaining the age of four weeks shall have had removed

from the web of one foot a portion thereof in the form of a "V" large enough to make a permanent well-defined mark, which shall be sufficient to identify it as a bird raised in domestication under a permit.

3. Any package in which such waterfowl or parts thereof or their eggs are transported shall have plainly and conspicuously marked on the outside thereof the name and address of the permittee, the number of his permit, the name and address of the consignee, and an accurate statement of the number and kinds of birds or eggs contained therein.

4. Applications for permits must be addressed to the Secretary of Agriculture, Washington, D. C., and must contain the following information: Name and address of applicant; place where the business is to be carried on; number of acres of land used in the business and whether owned or leased by the applicant; number of each species of waterfowl in possession of applicant; names of species and number of birds or eggs of each species if permission is asked to take waterfowl or their eggs; and the particular locality where it is desired to take such waterfowl or eggs.

5. A person granted a permit under this regulation shall keep books and records which shall correctly set forth the total number of each species of waterfowl and their eggs possessed on the date of application for the permit and on the first day of January next following; also for the calendar year for which permit was issued the total number of each species reared and killed, number of each species and their eggs sold and transported, manner in which such waterfowl and eggs were transported, name and address of each person from or to whom waterfowl and eggs were purchased or sold, together with number and species and whether sold alive or dead; and the date of each transaction. A written report correctly setting forth this information shall be furnished the Secretary during the month of January next following the issuance of the permit.

6. A permittee shall at all reasonable hours allow any authorized employee of the United States Department of Agriculture to enter and inspect the premises where operations are being carried on under this regulation and to inspect the books and records of such permittee relating thereto.

7. Permits issued under this regulation shall be valid only during the calendar year of issue, shall not be transferable, and may be revoked by the Secretary, if the permittee violates any of the provisions of the Migratory Bird Treaty Act or of the regulations thereunder.

8. A person engaged in the propagation of migratory waterfowl on the date on which these regulations become effective will be allowed until September 30, 1918, to apply for the permit required by this regulation, but he shall not take any migratory waterfowl without a permit.

[As amended October 25, 1918, and July 9, 1920.]

REGULATION 9.—PERMITS TO COLLECT MIGRATORY BIRDS FOR SCIENTIFIC PURPOSES.

A person may take in any manner and at any time migratory birds and their nests and eggs for scientific purposes when authorized by a permit issued by the Secretary, which permit shall be carried on his person when he is collecting specimens thereunder and shall be exhibited to any person requesting to see the same.

Application for a permit must be addressed to the Secretary of Agriculture, Washington, D. C., and must contain the following information: Name and address of applicant and name of State, Territory, or District in which specimens

are proposed to be taken and the purpose for which they are intended. Each application shall be accompanied by certificates from two well-known ornithologists that the applicant is a fit person to be intrusted with a permit.

The permit will authorize the holder thereof to possess, buy, sell, and transport in any manner and at any time migratory birds, parts thereof, and their nests and eggs for scientific purposes. Public museums, zoological parks and societies, and public scientific and educational institutions may possess, buy, sell, and transport in any manner and at any time migratory birds and parts thereof, and their nests and eggs for scientific purposes without a permit, but no specimens shall be taken without a permit. The plumage and skins of migratory game birds legally taken may be possessed and transported by a person without a permit.

A taxidermist when authorized by a permit issued by the Secretary may possess, buy, sell, and transport in any manner and at any time migratory birds and parts thereof legally taken.

Permits shall be valid only during the calendar year of issue, shall not be transferable, and shall be revocable in the discretion of the Secretary. A person holding a permit shall report to the Secretary on or before January 10 following its expiration the number of skins, nests, or eggs of each species collected, bought, sold, or transported.

Every package in which migratory birds or their nests or eggs are transported shall have clearly and conspicuously marked on the outside thereof the name and address of the sender, the number of the permit in every case when a permit is required, the name and address of the consignee, a statement that it contains specimens of birds, their nests, or eggs for scientific purposes, and, whenever such a package is transported or offered for transportation from the Dominion of Canada into the United States or from the United States into the Dominion of Canada, an accurate statement of the contents.

[As amended October 25, 1918.]

REGULATION 10.—PERMITS TO KILL MIGRATORY BIRDS INJURIOUS TO PROPERTY.

When information is furnished the Secretary that any species of migratory bird has become, under extraordinary conditions, seriously injurious to agriculture or other interests in any particular community, an investigation will be made to determine the nature and extent of the injury, whether the birds alleged to be doing the damage should be killed, and, if so, during what times and by what means. Upon his determination an appropriate order will be made.

REGULATION 11.—STATE LAWS FOR THE PROTECTION OF MIGRATORY BIRDS.

Nothing in these regulations shall be construed to permit the taking, possession, sale, purchase, or transportation of migratory birds, their nests, and eggs contrary to the laws and regulations of any State, Territory, or District made for the purpose of giving further protection to migratory birds, their nests, and eggs when such laws and regulations are not inconsistent with the convention between the United States and Great Britain for the protection of migratory birds concluded August 16, 1916, or the migratory bird treaty act and do not extend the open seasons for such birds beyond the dates prescribed by these regulations.

[Added by proclamation of October 25, 1918, as amended July 9, 1920.]

ORDER.

PERMITTING THE KILLING OF BOBOLINKS, COMMONLY KNOWN AS REEDBIRDS OR RICE BIRDS, WHICH HAVE BECOME SERIOUSLY INJURIOUS TO AGRICULTURAL INTERESTS.

[Issued January 17, 1919.]

Information having been furnished the Secretary of Agriculture that bobolinks, commonly known as reedbirds or rice birds, have become seriously injurious to the rice crops of North Carolina, South Carolina, Georgia, and Florida, and an investigation having been duly and regularly made pursuant to law, and it having been determined by the Secretary of Agriculture that said birds have become, under extraordinary conditions, seriously injurious to the rice crops in said States and that the injuries so inflicted by them can not adequately be controlled in the communities immediately affected, and that they should therefore be killed in the manner, during the seasons, and in the States and District hereinafter provided,

Now, therefore, I, D. F. Houston, Secretary of Agriculture, pursuant to authority in me vested by the Migratory-Bird Treaty Act of July 3, 1918, and in conformity with Regulation 10 of the Migratory-Bird Treaty-Act Regulations approved and proclaimed July 31, 1918, do order that until further notice persons may kill by shooting, bobolinks, commonly known as reedbirds or rice birds, from half an hour before sunrise to sunset, from September 1 to October 30, inclusive, in the States of New Jersey, Pennsylvania, Delaware, and Maryland and the District of Columbia, and from August 16 to November 15, inclusive, in the States of Virginia, North Carolina, South Carolina, Georgia, and Florida, but the birds so killed shall not be sold, offered for sale, or shipped for purposes of sale, or be wantonly wasted or destroyed, but they may be used for food purposes by the persons killing them, and they may be transported to hospitals and charitable institutions for use as food.

D. F. HOUSTON,
Secretary of Agriculture.

CANADIAN REGULATIONS UNDER MIGRATORY-BIRDS CONVENTION ACT.

[Promulgated May 11, 1918; amended May 11, 1920.]

1. In these regulations, unless the context otherwise requires:—
 - (a) "Migratory game birds" means the following:
 - Anatidæ or waterfowl, including brant, wild ducks, geese and swans;
 - Gruidæ or cranes, including little brown[,] sandhill and whooping cranes;
 - Rallidæ or ralls, including coots, gallinules and sora and other ralls;
 - Limicolæ or shorebirds, including avocets, curlew, dowitchers, godwits, knots, oyster catchers, phalaropes, plovers, sandpipers, snipe, stilts, surf birds, turnstones, willet, woodcock, and yellowlegs;
 - Columbidæ or pigeons, including doves and wild pigeons;
 - (b) "migratory insectivorous birds" means the following:—
 - Bobolinks, catbirds, chickadees, cuckoos, flickers, flycatchers, grosbeaks, humming birds, kinglets, martins, meadowlarks, nighthawks or bull bats, nuthatches, orioles, robins, shrikes, swallows, swifts, tanagers, titmice, thrushes, vireos, warblers, waxwings, whippoorwill, woodpeckers, and wrens, and all other perching birds which feed entirely or chiefly on insects;
 - (c) "migratory nongame birds" means the following:—
 - Auks, auklets, bitterns, fulmars, gannets, grebes, gulleimots, gulls, herons, jaegers, loons, murrees, petrels, puffins, shearwaters, and terns.

2. Close seasons.—No person shall kill, capture, injure, take, molest, sell or offer for sale any migratory game birds except during the following periods in the various Provinces:—

Ducks, Geese, Brant, or Rails.

In Prince Edward Island, Quebec, Ontario, Alberta, Northwest Territories, and Yukon Territory: September 1 to December 14, both dates inclusive.

In Manitoba: September 15 to November 30, both dates inclusive.

In Nova Scotia, New Brunswick, and Saskatchewan: September 15 to December 31, both dates inclusive.

In British Columbia (northern and eastern districts): From the first Saturday next following August 31, in any year to a date 3 months and 15 days later, both dates inclusive.

In that portion of the western district to the north of the fifty-first parallel of latitude: From the first Saturday next following September 7, in any year to a date 3 months and 15 days later, both dates inclusive.

Ducks and Rails.

In British Columbia (in that portion of the western district to the south of the fifty-first parallel of latitude): From the first Saturday next following October 14, in any year to a date 3 months and 15 days later, both dates inclusive.

Geese and Brant.

In British Columbia (in that portion of the western district to the south of the fifty-first parallel of latitude): From the first Saturday next following November 7 in any year to a date 3 months and 15 days later both dates inclusive.

Shorebirds or Waders, including only the following: Woodcock, Wilson or Jack-snipe, black-breasted and golden plovers and the greater and lesser yellow-legs.

In Prince Edward Island, Nova Scotia, and New Brunswick: August 15 to November 30, both dates inclusive.

Except that on woodcock and Wilson or Jack-snipe the open season in Prince Edward Island, New Brunswick, and Nova Scotia, shall be from September 15 to November 30, both dates inclusive.

In Quebec, Ontario, Alberta, Northwest Territories, and Yukon Territory: September 1 to December 14, both dates inclusive.

Except that on woodcock the open season in Ontario shall be from: October 15 to November 14, both dates inclusive.

In Manitoba: September 15 to November 30, both dates inclusive.

In Saskatchewan: September 15 to December 31, both dates inclusive.

In British Columbia (northern and eastern districts): From the first Saturday next following August 31, in any year to a date 3 months and 15 days later, both dates inclusive.

In that portion of the western district to the north of the fifty-first parallel of latitude: From the first Saturday next following September 7, in any year to a date 3 months and 15 days later, both dates inclusive.

In that portion of the western district to the south of the fifty-first parallel of latitude: From the first Saturday next following October 14, in any year to a date 3 months and 15 days later, both dates inclusive.

Provided, however, That Indians and Eskimos may take scoters or "Siwash ducks" for food at any time of the year, but scoters so taken shall not be sold.

For the purpose of this or any other regulation, the Province of British Columbia shall be divided into three districts, to be known as the northern, eastern, and western districts:

Northern district shall mean and include the electoral district of Atlin and all that portion of the Province situated and lying to the north of the main line of the Grand Trunk Pacific Railway and to the east of the summit of the Cascade Range.

Eastern district shall mean and include all that portion of the Province situated and lying to the east of the summit of the Cascade Range and south of the main line of the Grand Trunk Pacific Railway.

Western district shall mean and include all that portion of the Province situated and lying to the west of the summit of the Cascade Range and south of the electoral district of Atlin.

[As amended May 11, 1920.]

3. The killing, capturing, taking, injuring, or molesting of migratory insectivorous birds, their eggs, or nests, is prohibited throughout the year, except as hereinafter provided.

4. The killing, taking, injuring, capturing or molesting of migratory non-game birds or their eggs or nests, except as herein or hereinafter provided, is prohibited throughout the year; *Provided, however*, That Indians and Eskimos may take at any season auks, auklets, guillemots, murres and puffins and their eggs for human food and their skins for clothing, but birds and eggs taken in virtue of this exemption shall not be sold or offered for sale or otherwise traded.

5. A close season shall continue until the 1st day of January, 1928, on the following migratory game birds:—band-tailed pigeons, little brown, sandhill and whooping cranes, swans, curlew, and all shore birds (except the black-breasted and golden plover, Wilson or jack snipe, woodcock, and the greater and lesser yellowlegs). In the Province of British Columbia during such period the close season on cranes, swans, and curlew, shall be made by the proper authorities of that Province within the general dates and limitations elsewhere prescribed in these regulations for the respective groups to which these birds belong or greater restrictions on the hunting of these birds shall be made should the aforementioned authorities deem such further restriction desirable as provided by Article III of the Convention between His Majesty and the United States of America, scheduled to chapter 18, 7-8 George V.

6. A close season shall continue until the 1st day of January, 1923, on the wood duck and elder duck, except that in the Province of British Columbia, the wood duck shall be protected by such special means or regulations as the proper authorities of that Province may deem appropriate, as provided by the convention referred to in clause 5.

7. The taking of the nests or eggs of migratory game, migratory insectivorous or migratory non-game birds is prohibited except as otherwise provided in the regulations.

8. *Sale of migratory game birds.*—Notwithstanding any provision of section 2 of these regulations, in the Provinces of New Brunswick, Ontario, Manitoba, Saskatchewan and British Columbia no person shall sell, buy, trade, or traffic in any migratory game bird, killed or taken during the open seasons hereunder.

8A. *Bag limits.*—No person shall kill during any day, or during any season, migratory game birds in the various Provinces in excess of the numbers set forth as follows:—

In Nova Scotia, New Brunswick, Prince Edward Island, Quebec, Ontario, Northwest Territories and Yukon Territory, in any day (except that in Ontario no person shall kill in any one season in excess of 200 ducks).

Ducks.—Twenty-five in the aggregate of all kinds.

Geese.—Fifteen in the aggregate of all kinds.

Brant.—Fifteen in the aggregate of all kinds.

Rails, coots and gallinules.—Twenty-five in the aggregate of all kinds.

Black-bellied and golden plovers and greater and lesser yellowlegs.—

Fifteen in the aggregate of all kinds.

Wilson snipe or jack-snipe.—Twenty-five.

Woodcock.—Ten.

Doves.—Twenty-five.

In Manitoba in any day:—

Ducks.—Twenty before October 1st, and 40 thereafter in the aggregate of all kinds.

Geese.—Ten in the aggregate of all kinds.

Brant.—Fifteen.

Rails, coots and gallinules.—Twenty-five in the aggregate of all kinds.

Black-bellied and golden plovers and greater and lesser yellowlegs.—

Fifteen in the aggregate of all kinds.

Wilson snipe or jack-snipe.—Twenty-five.

Woodcock.—Ten.

Doves.—Twenty-five.

And in Manitoba in any open season in excess of 250 ducks.

In Alberta in any day:—

Ducks.—Thirty in the aggregate of all kinds.

Geese.—Fifteen in the aggregate of all kinds.

Brant.—Fifteen.

Rails, coots and gallinules.—Twenty-five in the aggregate of all kinds.

Black-bellied and golden plovers and greater and lesser yellowlegs.—

Fifteen in the aggregate of all kinds.

Wilson snipe or jack-snipe.—Twenty-five.

Woodcock.—Ten.

Doves.—Twenty-five.

And in Alberta in any open season in excess of 200 ducks.

In Saskatchewan in any day:—

Ducks, geese, and brant.—Fifty in the aggregate of all kinds.

Rails, coots and gallinules.—Twenty-five in the aggregate of all kinds.

Black-bellied and golden plovers and greater and lesser yellowlegs.—

Fifteen in the aggregate of all kinds.

Wilson snipe or jack-snipe.—Twenty-five.

Woodcock.—Ten.

Doves.—Twenty-five.

And in Saskatchewan in any open season in excess of 250 birds of the family *Anatidæ*, including *ducks, geese, and brant*.

In British Columbia in any day:—

Ducks.—Twenty in the aggregate of all kinds.

Geese.—Ten in the aggregate of all kinds.

Brant.—Fifteen.

Rails, coots and gallinules.—Twenty-five in the aggregate of all kinds.

Black-bellied and golden plovers and greater and lesser yellowlegs.—

Fifteen in the aggregate of all kinds.

Wilson snipe or jack-snipe.—Twenty-five.

Woodcock.—Ten.

Doves.—Twenty-five.

And in British Columbia in any open season in excess of 250 ducks.

And in British Columbia in any open season in excess of 50 geese.

8B. *Shooting restrictions.*—(a) No person shall kill or attempt to kill any migratory game birds during the open seasons provided hereunder except with a gun not larger than number 10 gauge.

(b) No person shall kill or attempt to kill any migratory game birds by the use of any automatic, swivel, or machine gun or battery or by the use of any aeroplane, power-boat, sailboat, or sunken boat.

(c) No person shall kill or attempt to kill any migratory game bird between the hours of sunset and sunrise.

(d) No person shall kill or attempt to kill from any motor vehicle or horse-drawn vehicle any migratory game bird.

8C. *Scientific permits.*—Migratory game, migratory insectivorous or migratory non-game birds or parts thereof or their eggs or nests may be taken, bought, sold, shipped, transported or possessed for scientific purposes but only on the issue of a permit by the Minister or by any person duly authorized by him.

Such permits may, upon application, be granted to recognized museums, or scientific societies, and to any person furnishing written testimonials from two well-known ornithologists.

A return of specimens taken under such a permit shall be made to the Minister upon the expiration of the permit.

8D. *Propagation of migratory birds.*—(a) Migratory game, migratory insectivorous or migratory non-game birds, or their eggs, protected under regulations made pursuant to the Migratory Birds Convention Act, may be taken at any time and in any manner for propagating purposes only on the issue of a permit by the Minister or by any person duly authorized by him. Migratory game, migratory insectivorous or migratory non-game birds, or their eggs so taken may be possessed by the permittee and may be sold and transported by him to any person holding a permit for propagating purposes issued by the Minister or by any person duly authorized by him.

(b) A person authorized by a permit issued for propagating purposes under this regulation may possess, buy, sell, or transport migratory game, migratory insectivorous, or migratory non-game birds, or their increase of [or] eggs, for propagating purposes. Such migratory game, migratory insectivorous, or migratory non-game birds, except the birds taken under paragraph (a) of this regulation, may be killed by him in any manner except by shooting. The unplucked carcasses or the plucked carcasses with heads attached thereto of such birds may be sold and transported by the permittee to any person for consumption, or to the keeper of a hotel, restaurant, or boarding house, or to a dealer in meat or game, or to a club for sale or service to their patrons, all of whom may possess such carcasses for actual consumption without a permit.

(c) A person granted a permit under this regulation shall keep books and records which shall correctly set forth at all times the total number of each species of migratory game, migratory insectivorous, or migratory non-game birds or their eggs, taken or in his possession. A written report shall be furnished the Minister during the month of January next following the issuance of the permit. This report shall state the total number of each species reared and killed, the number of each species, or their eggs, sold and transported, the manner in which such species or eggs were transported, the name and address of each person from or to whom such species or eggs were purchased or sold together with number and species and whether sold alive or dead; and the date of each transaction.

(d) Application for permits to take such birds for propagating purposes shall be accompanied by a statement showing:

- (1) The full name and Post Office address of the applicant.
- (2) The species of birds or eggs that it is desired to take.
- (3) The number.
- (4) The place at which the birds or eggs are to be taken.

Applications for permits to possess, buy, sell, or transport such birds for propagating purposes shall be accompanied by a statement showing:

- (1) The full name and Post Office address of the applicant.
- (2) The species and number of birds that it is desired to possess.
- (3) The area and location of the land to be used in the business and whether owned or leased by the applicant.

(e) The Minister may require an applicant to furnish a bond in support of his application for a permit for propagating purposes.

(f) A permittee shall at all reasonable hours allow any game officer to enter and inspect the premises where operations are being carried on under these regulations and to inspect the books and records of such permittee relating thereto.

(g) No person holding a permit for propagating purposes shall sell migratory game, migratory insectivorous, or migratory non-game birds, raised and killed in captivity unless the same shall bear a metal tag. This tag shall be of a type approved by the Minister and shall contain the name or initials of the holder of the permit. It shall not be removed from the carcass.

8E. *Termination of permits.*—All permits and licenses shall terminate at the end of the calendar year in which they shall have been issued. They shall not be transferable and shall be revocable at the discretion of the Minister.

8F. *Taxidermists.*—No person shall engage in the business of a taxidermist without having first secured from the Minister a license so to do. The fee for this license shall be one dollar.

No taxidermist shall receive, prepare for exhibition purposes, or possess, any migratory game, migratory insectivorous, or migratory non-game bird, or any portion thereof, unless such bird has been legally killed, either in the open season for such bird, or by the holder of a permit for taking birds for scientific purposes.

Every licensed taxidermist shall annually make such returns as the Minister may require.

Every licensed taxidermist shall keep books and records which correctly set forth the name of each migratory game, migratory insectivorous, or migratory non-game bird received, the date and locality of capture, the date received, and the name and address of the owner of such bird. These books and records are to be open to inspection by any game officer at any reasonable time.

8G. *Labeling packages for shipment.*—Any package in which migratory game, migratory insectivorous, or migratory non-game birds or parts thereof, or their eggs or nests are shipped or transported for scientific or propagating purposes shall be clearly marked on the outside with the number of the permit, the name and address of the shipper and an accurate statement of the contents.

No transportation company shall accept for transportation any package containing eggs, nests, or parts of migratory game, migratory insectivorous or migratory non-game birds unless such packages shall be marked as hereinbefore required, and shipment of the same through the mails is prohibited, unless marked as aforesaid.

[As amended May 11, 1920.]

9. The shipment or export of migratory game, migratory insectivorous, or migratory non-game birds or their eggs from any Province during the close

season in such Provinces is prohibited except for scientific or propagating purposes and traffic between Canada and the United States in any such birds, or their eggs captured, killed, taken or shipped at any time contrary to the laws of the Province or State in which the same are captured, killed, taken or shipped, is likewise prohibited.

10. No person shall ship or offer for shipment from Canada to the United States any package containing migratory game, migratory insectivorous or migratory non-game birds, or any parts thereof or their eggs unless such package shall have the name and address of the shipper and an accurate statement of the contents clearly marked on the outside of such package.

No transportation company shall accept for transportation to the United States, any packages of migratory game, migratory insectivorous or migratory non-game birds or any parts thereof or their eggs unless such packages bear the name and address of the shipper and an accurate statement of the contents, and shipment of the same through the mails is prohibited unless marked as aforesaid.

11. If any of the migratory game, migratory insectivorous or migratory non-game birds should, under extraordinary conditions become seriously injurious to agricultural, fishing or other interests in any particular locality the Minister may issue permits to kill such birds so long as they shall continue to be injurious. Applications for such permits shall include a full statement describing:

(1) The species and an estimate of the number of birds committing the damage.

(2) The nature and extent of the damage.

(3) The extent of the agricultural or other interests threatened or involved.

Such permits shall be revocable at the discretion of the Minister. On the expiration of the permit the person to whom it is issued shall furnish to the Minister a written report showing the number of birds killed, the dates upon which they were killed and the disposition made of the dead birds.

No birds killed under such permits shall be shipped, sold or offered for sale.

12. *Introduction of Foreign Species of Migratory Birds Without Consent Prohibited.*—No person or organization shall introduce for the purpose of sport or acclimatization any species of migratory birds without the consent of the Minister in writing.

CANADIAN TARIFF ACT PROHIBITING IMPORTATION OF PLUMAGE.

The importation of bird plumage into Canada for millinery purposes is prohibited by tariff item 1212 under schedule C (prohibited goods) to the customs tariff, section 5, by the enactment of the Canadian customs tariff act of 1914. Item 1212 prohibits the entry of the following:

1212. Aligrettes, egret plumes, or so-called osprey plumes, and the feathers, quills, heads, wings, tails, skins, or parts of skins of wild birds either raw or manufactured; but this provision shall not come into effect until January 1, 1915, and shall not apply to—

(a) The feathers or plumes of ostriches;

(b) The plumage of the English pheasant and the Indian peacock;

(c) The plumage of wild birds ordinarily used as articles of diet;

(d) The plumage of birds imported alive, nor to

(e) Specimens imported under regulations of the minister of customs for any natural-history or other museum or for educational purposes.

OFFICIALS FROM WHOM COPIES OF GAME LAWS MAY BE OBTAINED.

- Alabama:** Commissioner of conservation, Montgomery.
- Alaska:** The governor, Juneau; Secretary of Agriculture, Washington, D. C.
- Arizona:** State game warden, Phoenix.
- Arkansas:** Secretary, game and fish commission, Little Rock.
- California:** Executive officer, fish and game commission, Postal Telegraph Building, San Francisco.
- Colorado:** State game and fish commissioner, Denver.
- Connecticut:** Secretary, commission of fisheries and game, Hartford.
- Delaware:** Chief game warden, Dover.
- District of Columbia:** Superintendent metropolitan police, Washington.
- Florida:** Secretary of State, Tallahassee.
- Georgia:** Game and fish commissioner, Atlanta.
- Idaho:** Fish and game warden, Boise.
- Illinois:** Chief game and fish warden, Springfield.
- Indiana:** Superintendent, division of fisheries and game, State House, Indianapolis.
- Iowa:** State fish and game warden, Lansing.
- Kansas:** State fish and game warden, Pratt.
- Kentucky:** Executive agent, game and fish commission, Frankfort.
- Louisiana:** Commissioner of conservation, Court Building, New Orleans.
- Maine:** Commissioner of inland fisheries and game, State House, Augusta.
- Maryland:** State game warden, 512 Munsey Building, Baltimore.
- Massachusetts:** Director, division of fisheries and game, State House, Boston.
- Michigan:** Commissioner game, fish, and forest-fire department, Lansing.
- Minnesota:** Game and fish commissioner, St. Paul.
- Mississippi:** Secretary of State, Jackson.
- Missouri:** Game and fish commissioner, Jefferson City.
- Montana:** State game warden, Helena.
- Nebraska:** Chief deputy, game and fish commission, Lincoln.
- Nevada:** State fish and game warden, Carson City.
- New Hampshire:** Fish and game commissioner, Sunapee.
- New Jersey:** Secretary, board of fish and game commissioners, Trenton.
- New Mexico:** Game and fish warden, Santa Fe.
- New York:** Secretary of conservation commission, Albany.
- North Carolina:** Secretary, Audubon Society of North Carolina, Raleigh.
- North Dakota:** Secretary, game and fish board, Steele.
- Ohio:** Chief game warden, board of agriculture, Columbus.
- Oklahoma:** State game warden, Oklahoma City.
- Oregon:** State game warden, Portland.
- Pennsylvania:** Secretary, board of game commissioners, Harrisburg.
- Rhode Island:** Chairman, commissioners of birds, Providence.
- South Carolina:** Chief game warden, Columbia.
- South Dakota:** State game warden, Pierre.
- Tennessee:** State game and fish warden, Nashville.
- Texas:** Game, fish, and oyster commissioner, Austin.
- Utah:** Fish and game commissioner, Salt Lake City.
- Vermont:** Fish and game commissioner, Montpelier.
- Virginia:** Commissioner of game and inland fisheries, Richmond.
- Washington:** Chief game warden and State fish commissioner, Seattle; chief deputy game warden, Yakima.
- West Virginia:** Forest, game, and fish warden, Elkins.
- Wisconsin:** Secretary, conservation commission, Madison.
- Wyoming:** State game warden, Cheyenne.
- Dominion legislation:** Commissioner of parks, Ottawa.
- Alberta:** Chief game guardian, Edmonton.
- British Columbia:** Secretary, game conservation board, Vancouver.
- Manitoba:** Chief game guardian, Winnipeg.
- New Brunswick:** Chief game and fire warden, Fredericton.
- Northwest Territories:** Commissioner of parks, Ottawa.
- Nova Scotia:** Chief game commissioner, Halifax.
- Ontario:** Superintendent game and fisheries, Toronto.
- Prince Edward Island:** Chief game officer for migratory birds, Maritime Provinces, Wolfville, Nova Scotia.
- Quebec:** General inspector of fisheries and game, Quebec.
- Saskatchewan:** Chief game guardian, Regina.
- Yukon:** Gold commissioner, Dawson.
- Colony of Newfoundland:** Secretary, game and inland fisheries board, St. Johns.
- Lower California (Northern District):** Governor, Mexicali.

**PUBLICATIONS OF THE U. S. DEPARTMENT OF AGRICULTURE
RELATING TO GAME.**

AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT.

- Bird Migration. (Department Bulletin 185.)
Eleven Important Wild-duck Foods. (Department Bulletin 205.)
Propagation of Wild-duck Foods. (Department Bulletin 465.)
Waterfowl and Their Food Plants in the Sandhill Region of Nebraska. (Department Bulletin 794.)
Chronology and Index of the More Important Events in American Game Protection, 1776-1911. (Biological Survey Bulletin 41.)
Our Shorebirds and Their Future. (Yearbook Separate 642.)
The Great Plains Waterfowl Breeding Grounds and Their Protection. (Yearbook Separate 723.)
Federal Protection of Migratory Birds. (Yearbook Separate 785.)
Some Common Game, Aquatic, and Rapacious Birds in Relation to Man. (Farmers' Bulletin 497.)
Laws Relating to Fur-bearing Animals, 1920. (Annual publication, that for 1920, Farmers' Bulletin 1165.)
Directory of Officials and Organizations Concerned with the Protection of Birds and Game, 1920. (Annual publication, that for 1920, Department Circular 131.)

**FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING
OFFICE, WASHINGTON, D. C.**

- Distribution and Migration of North American Rails and Their Allies. (Department Bulletin 128.) Price, 10 cents.
Mortality among Waterfowl around Great Salt Lake, Utah. (Department Bulletin 217.) Price, 5 cents.
Food Habits of the Mallard Ducks of the United States. (Department Bulletin 720.) Price, 5 cents.
Lead Poisoning in Waterfowl. (Department Bulletin 793.) Price, 5 cents.
Our National Elk Herds. (Department Circular 51.) Price, 10 cents.
Hunting Licenses: Their History, Objects, and Limitations (1904). (Biological Survey Bulletin 19.) Price, 10 cents.
The Bob-white and Other Quails of the United States in Their Economic Relations. (Biological Survey Bulletin 21.) Price, 15 cents.

FARMERS' BULLETIN 1139
UNITED STATES DEPARTMENT OF AGRICULTURE

A Method *of* Analyzing the Farm Business



A FARM to be successful should maintain its productivity and should return a reasonable wage for the labor of the farmer and his family, after paying farm expenses and deducting a fair rate of interest on the investment.

Four important factors in the success of a farm business are size of business, yield of crops, returns from live stock, and efficiency in the use of labor.

What is the size of your farm business?

What part of your investment is in land, buildings, live stock, machinery, and other capital?

Is your crop area properly proportioned to the various crops with regard to profits? With regard to labor distribution?

How do your crop yields compare with the average yields of the locality?

What classes of live stock return you the most money?

How do the returns from your live stock compare with the average of your locality?

How many acres of crops do you raise per man? Per horse?

Is your farm so organized that each part of the business is yielding satisfactory returns?

How much have you left for your own labor, after deducting from your total receipts your year's expenses, value of labor performed by members of your family, and interest on your investment?

How much does the farm contribute toward your family living?

This bulletin outlines a system of analyzing the farm business, designed to help the farmer answer such questions as these and thus locate the strong and weak points in his plan of management.

Record your year's financial transactions in the blanks provided in this bulletin and apply the tests of farm efficiency to your own business.

Contribution from the Office of Farm Management

H. C. TAYLOR, Chief

Washington, D. C.

June, 1920

A METHOD OF ANALYZING THE FARM BUSINESS.

H. M. DIXON, *Assistant Agriculturist.*
H. W. HAWTHORNE, *Scientific Assistant.*

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WHAT AN ANALYSIS SHOWS.

THIS BULLETIN outlines a method of analyzing the farm business to determine the investment, receipts, expenses, and profits. It also includes blanks for use in making such an analysis and recording the amount and value of farm products contributed toward the family living. Its purpose is to assist farmers to a better understanding of the financial side of their business. Thousands of farms have been studied by this method within the past few years, with the object of analyzing their operations from a business standpoint and learning some of the more important reasons for their success or failure. Experience shows that it is not always possible to distinguish profitable farms merely by casual observation. Where a farm is operated as a large business, if free from debt, even a low rate of interest on the capital invested without any wages for the operator may return sufficient funds to give the place a prosperous appearance. In other cases an appearance of prosperity may be due quite largely to income from outside sources. A farm can not properly be called successful unless it pays a fair rate of interest on the investment, returns fair wages for the farmer's labor, and, at the same time, maintains or increases the fertility of the soil.

Most farmers have the details of their business sufficiently well in mind for the purposes of analysis, but they are not always able to summarize these details into a concrete statement. They realize that the gain from a large business should be more than from a small one, that good cows are more profitable than poor ones, and that good crops are more desirable than those that barely pay for

NOTE.—A part of the material in this bulletin was first issued in 1915 as U. S. Department of Agriculture Farmer's Bulletin 661, by E. H. Thomson and H. M. Dixon. Several years' experience with the application of this method to the business analysis of a large number of farms has made possible the revision of the former bulletin.

harvesting. Their main difficulty has been that they have had no convenient way of determining just how good or how poor the business really was; in other words, no way of measuring its efficiency. With such an analysis as outlined herein, a farmer can more readily find the strong and weak points in his system of management and thus make changes with some assurance that they will result in greater profits.

Agricultural teachers, county agents, and other extension workers, as well as farmers, will find the blanks used in this form of analysis helpful. Teachers may give copies to their scholars for use in making records of their home farms. These records may then be summarized and furnish information to both teacher and scholars concerning economic phases of the local agriculture. Groups of farmers assembled for a discussion of the economic side of their business may find the blanks outlined in this bulletin of value, as arrangements can be made so that each farmer can be furnished a copy to figure his own farm profits. Later meetings may be devoted to a discussion of the results. Work of this kind will help reveal the true status of the local agriculture and show some of the problems confronting the farmers. With the blanks properly filled, the information should be helpful in solving many problems of farm management.

The blanks may also be filled in by the individual farmer and sent to the State Agricultural College or to the United States Department of Agriculture for suggestions as to improvements in his system of management.

When these data are obtained for farms where no accounts are kept, some of the items to be recorded may appear to be rough estimates, but experience in studies of this nature has shown that farmers can give most of the details of their business if the questions asked correspond to the terms in which they think. A farmer may not know, offhand, what his total farm income is, but he does know with considerable accuracy the facts necessary to determine this income. It is important to bear in mind that the final results in the analysis of the farm business are determined mainly by a few large items which the farmer knows quite accurately. A variation of a few dollars in the final result should not seriously affect the conclusions to be drawn as to the profitableness or unprofitableness of the farm business.

FARM ACCOUNTS.

Farm accounts may be grouped into two classes: (1) Those pertaining to the farm business as a whole, or "financial accounts," and (2) those pertaining to an analysis of the various enterprises, commonly called "detail cost accounts." The method presented

here pertains to the analysis of the farm business as a whole. In order properly to analyze each enterprise it is necessary in addition to this analysis to obtain labor and other records for all the enterprises and feed records for each live-stock enterprise.

In making a record of the farm business, some accounts are of value. Many farmers have a record of the more important financial transactions. The accounts will vary on different farms, but a memorandum of all farm receipts and expenses is valuable when summarizing the year's business. Farm accounting is more a question of knowing what accounts to keep and what use to make of them than of the kind of form or blank. This method of farm analysis will suggest the accounts of most value.¹

Many of the State agricultural colleges and experiment stations have prepared a simple financial record book for farmers. These books which are prepared in connection with the farm management extension work are put out either free, or at a nominal charge to cover the cost of printing. Those interested in securing information regarding account books or other blank forms for keeping accounts should get in touch with their State agricultural colleges or experiment stations. The local county agricultural agent may be able to supply books prepared for use in the State.

METHOD OF FARM ANALYSIS.

The blank forms outlined on pages 29 to 40 have been prepared for use in determining the net income from the farm business. Space is also provided for recording the amount and value of farm products furnished the family. If a farmer is not interested in this latter phase of the analysis, the financial analysis may be determined independently and the spaces provided for family-used products left

¹ The advent of Federal and State income-tax laws makes it necessary for a large percentage of farmers to submit reports of their income, even though they may not have to pay any income tax. Farm accounting from the farm-management viewpoint is primarily for the purpose of enabling a man to improve the organization of his farm business. However, many farmers keep a farm record for income-tax purposes. If the income tax is reported on the accrual (inventory) basis, the opening inventory must be recorded at the beginning of the year, and not made up from memory at the end of the year. Whether a man elects to report his income on the cash receipt and disbursement basis or the accrual (inventory) basis, an inventory aids materially in determining the depreciation which should be claimed on farm buildings, farm machinery, work stock, breeding stock, and other farm equipment. A record of receipts and expenditures is also valuable because many small cash transactions take place in a year's farm business which are easily forgotten when no record is kept.

It is very desirable in the long run that a farmer report his taxable income on the accrual basis rather than on the cash receipt and disbursement basis, because the accrual basis permits crediting to each year the income derived from that year's business, whereas the cash receipt and disbursement basis credits the business with the actual cash transactions in that year, and these may sometimes be abnormal. For example, a farmer may accumulate a surplus of stock over several years which is sold at one time. Unless he had credited to previous years the accrued value of such sale stock he makes himself liable to taxation for the full amount of income in the year in which the live stock is sold, which often subjects that year's income not only to the normal tax but to high surtaxes as well. In other years he perhaps has not had sufficient income to offset his expenses and personal exemptions. Some approved system of accounts is recommended by the Internal Revenue Bureau for every farmer who is required to make an income-tax report.

blank. The wide variation in the kinds of farming carried on in different parts of the country renders it impracticable to prepare a single set of blanks for all conditions. The forms, are, therefore, rather general, and it may often be necessary to insert items not listed. Since more than one-third of the farms in this country are operated by tenants, the blanks have been designed for use in analyzing the business of a farm operated by either the owner or tenant.

FARM TENURE.

In farm-management studies a farm is usually understood to be all the land operated as one unit. Exception to this may be necessary in some cases, for instance, where the operator rents out single fields it may be well to include his share of the returns from the rented-out areas. The farm may consist of both owned and rented land, if all, or nearly all, this area is operated by one set of machinery, horses, workmen, etc. When a man owns two farms, operated rather independently of each other, they should be considered separate farms. The operator is the person who is responsible for the year's farming operations. Thus, if an owner directs the farm operations he is the operator; but if a renter directs the operations, the owner is the landlord and the tenant is the operator.

The cropper, share hand, halver, or tenant laborer usually furnishes the manual labor and little or none of the working equipment. He, therefore, bears close relation to the wage hand, the main difference being that he is paid a share of the farm products instead of cash wages for his services. The farm operator furnishes all or nearly all the capital, pays nearly all the expenses, and exercises most of the supervision of the business. Such a proposition may be considered a part of the farm business; and the value of the share of products received by the cropper or share hand, minus any expense other than labor paid by him, may be inserted as the expense for "cropper" labor (blank form, p. 35). The value of the products he received must also be included in the receipts, and the other expenses he paid included under "Current expenses." The operations of croppers or share hands who furnish any considerable part of the operating equipment and operate a part of the farm independently of the rest of the business should usually be handled as separate propositions. The blank is designed for handling such propositions in the way which seems to represent best the conditions on the individual farm.

FARM INVENTORY.

An inventory is a list of the amount and value of all farm property. In this method of analysis the farm inventory is very important, and space is provided for making such a record at the beginning and end of the year. Such an inventory shows whether or not

the business has been increased or decreased during the year. Whether or not the year as a whole has been a profitable one can not well be determined without the inventory.

In taking the farm inventory the date when the farm year begins will vary. Some farmers begin their year's accounting on January 1, while others find some other date more desirable. In some sections it corresponds to the time tenants ordinarily change farms. It is a practice on many farms to close the accounts at March 1 or April 1, as this represents the time of year in many regions when practically all feeding operations from the preceding year have been completed. The fundamental principle in taking an inventory is to choose a time when the least feed and unsold products are on hand.

FARM AREA.

The farm area (blank form, p. 29) should include all the land operated as one farm. The farm acreage is separated into eight divisions according to utilization, namely, (1) acres in crops, (2) acres in tillable land fallowed or idle, (3) acres in rotation pasture, (4) acres in permanent pasture tillable, (5) acres in open or cleared pasture not tillable, (6) acres in woodland pastured, (7) acres in woodland not pastured, (8) acres in waste land, roads, etc. If more than one crop is grown on any of the land during the year, the acreage should be counted but once for determining the "acres in crops."

CROP RECORD.

The blank form for the crop record is shown on pages 30 and 31. Space is provided for recording the acreage and yield of each crop, the amount and value of the operator's or the landlord's sales, and the amount and value of crops for family use. Crops grown that are not mentioned in this schedule should be written in, using the blank space, or spaces provided by scratching out the names of crops not grown in the locality. The sum of the acres in the several crops should equal the "Acres in crops" shown on page 29. If a second crop is grown on any of the fields during the year, the acreage should be "ringed" (as ⊗) to avoid confusion in adding the acres in crops. Under "Sales" all amounts sold from the farm or held for sale should be entered. Crops fed to live stock on the farm should not be included as sales. Crops held for sale from previous years should not be inventoried, as they are a part of the previous year's business, but crops held from the previous year for feeding on the farm must be inventoried under "Feed and supplies" (p. 36).

On tenant farms any portion of the tenant's share of crops sold or held for sale is listed under the heading "Operator's sales," while any of the landlord's crops sold, including those held for sale, are listed

under the heading "Landlord's sales." Where the landlord transfers any of his share of crops to another farm, the value of these should be entered as sales for the farm from which they are removed. When farmers operate their own farms and rent additional land, any of the crops sold from their own farm or any of their share sold from rented land should be entered under the heading "Operator's sales."

LIVE-STOCK RECORD.

The blank form for the live-stock record is shown on pages 32 and 33. This form provides for a record of the number and value of all kinds of live stock at the beginning and at the end of the year, of all sales and purchases within the year, and of the number and value of all animals that died or have been killed and used by the family within the year. The record of all live stock furnished hired labor is also important on some farms, and should be duly recorded. There may be a variation in the number of any kind of stock at the beginning and end of the year, according to the number bought, sold, raised, died, or slaughtered. The number of each kind of stock on hand at the beginning of the year, plus the number purchased and raised, minus the number sold, that have died, and have been slaughtered, must equal the number on hand at the end of the year. Animals appearing in one class in the first inventory may appear in a more mature class in the second inventory, and animals born within the year may appear as sales and not in the inventories. The number of dairy cows is often increased during the year from animals classed as heifers in the first inventory. In the same way the number of heifers or steers may be increased during the year from animals classed as calves in the first inventory, or by purchases. All live stock both born and sold during the year will appear as sales, but not in the inventory. Conservative market prices should govern the live-stock inventory values. On all farms except those on which the landlord has a share of the live stock the record is made under the heading "Operator's live stock."

Live-stock products.—Space is provided in the blank form on page 34 for the amounts and values of all live-stock products sold, such as milk, butter, eggs, wool, etc. Any of these products exchanged for groceries and other supplies should be entered as sales. The principle to follow in recording the year's farm receipts is to include as receipts the value of all farm products leaving the farm, whether sold or given in exchange for other provisions. Space is also provided for entering the amount and value of live-stock products taken from the farm for family use.

Live-stock summary.—The space under the heading "Live-stock summary" (p. 34) is for a concise statement of the business transac-

tions for each kind of live stock and for the entire live-stock enterprise. For each kind of live stock add receipts from live-stock products and from sales and the inventory value at end of the year. From this sum subtract the sum of the purchases, plus the inventory value at the beginning of the year. The result is the increase or decrease in the financial transactions for each kind of live stock and for the total live-stock part of the farm business.

OTHER SOURCES OF INCOME.

The space under the heading "Other sources of income" (p. 34) is for recording such items as money received for man or team labor, machine work, and other sources of income outside the farm business to which some part of the business contributed. The value of dwelling, wood for fuel, and other items of home supplies furnished by the farm may be placed in the space provided in this form. The rent received from tenant houses or other buildings on the farm is a receipt, when the values of such buildings are included in the farm real-estate value. Where the value of "Feed and supplies" is greater at the end of the year than at the beginning, the difference is a receipt to the year's business, and may be transferred direct from the blank form on page 36 to the summary, page 38.

FARM EXPENSES.

The farm expenses may be considered under five divisions, namely: (1) Current expenses, (2) family labor, (3) decrease in value of feed and supplies, (4) live-stock decrease, and (5) depreciation charges.

The items of farm expense vary with the kind of farming and the region, and any items not included in the list given on page 35 should be written in.

Current expenses.—The expenses for paid labor constitute an important item on many farms and should be very carefully computed and placed in the spaces provided. For the board of hired labor either of two methods may be used in arriving at a charge for this item; the entire expense for the board of hired labor may be charged and the proportion of the board furnished by the farm carried as a receipt to the enterprises contributing, or the charge for board may be made for only the food purchased. The final result for most farms is practically the same by either method.

The next items of current expense relate to the repairs of machinery, buildings, fences, drains, terraces, etc. These also represent an important part of the expense of operating a farm. Determining the proper amount of expense to charge against each of these items for a

given year is often perplexing, because extensive repairs may be made within one year that will last over several years. For this reason space is provided for recording the expense for repairs of buildings, machinery, fences, etc., along with inventory values and depreciation charges (pp. 36 and 37). If the expense for repairs and improvements has not more than maintained the value of the farm, the entire expense may be charged against the one year's business. If the expense for repairs for the year is more than is necessary for maintaining the buildings, machinery, etc., the normal expense should be calculated as the charge to the year's business under current expenses. (For machinery, see blank form, p. 37, and for buildings, etc., see blank form, p. 36.) The other items of expense following are more or less self-explanatory. For many of the items of expense, space is provided for recording quantities such as the number of months of labor, the amount of fertilizer, etc., facts which add considerable value to the record. The item of "interest" at the foot of the list refers to interest paid upon money borrowed within the year to carry on the business, or for the purchase of feeding steers, lambs, etc., not represented in the farm inventories, and does not refer to interest on the farm mortgage.

Unpaid family labor.—The value of unpaid family labor is also an expense chargeable to the farm business, and it is taken care of in the summary form, page 38. This item is determined on the basis of what it would cost to have the same work done by hired help, or the amount of additional labor that the operator would have had to hire to carry on the same-sized business had the family labor not been available.

Feed and supply decrease.—Where the value of feed and supplies is less at the end of the year than at the beginning, the difference is an expense. This expense should be calculated from the feed and supply record, page 36, and transferred to the summary, page 38.

Live stock decrease.—If the value of live stock at the end of the year, plus the sales, is less than the value of live stock at the beginning of the year, plus purchases, the difference represents a loss, and should be charged as an expense. This will seldom occur except in case of disease or marked decrease in market value. This may be determined from the live-stock summary, page 34, and if a decrease exists it may be transferred directly to the proper space in the farm summary, page 38.

Depreciation of equipment and buildings.—In addition to the current farm expenses there are certain other items, such as depreciation, which may be called fixed charges. These occur in the records of all farms, though in varying degree. Buildings may be constructed so that they will last for 100 years, or they may have to be rebuilt

every 25 or 30 years. The life of machinery depends on the care given and the extent to which it is used. Although there is no appreciable expense each year, these buildings and machines eventually have to be replaced. It is proper that a proportionate share of this replacement cost should be charged against the farm each year; otherwise, whenever a new barn or dwelling is built the entire cost of this building would have to be charged against the business for that particular year. Depreciation charges, therefore, are merely a method of distributing these costs over the period of years that they are in use.

The amount of depreciation that should be charged each year as an expense is left to the judgment of the farmer. No set rules can be given, as no two farms are exactly alike in this respect. The sum of the amount of depreciation on machinery (blank form p. 37), plus the depreciation of buildings, fences, etc. (blank form p. 36), represents the amount to be transferred to the farm summary.

FARM INVESTMENT.

Farm investment, or farm capital, includes the value of all real estate, live stock, machinery and equipment, feed and supplies, and cash to run the business.

Real estate and improvements.—A record of the real estate and improvements is most interesting and valuable when made out in sufficient detail to make possible a study of the essential considerations. The space under "real estate" in blank form, page 36, is for recording the value of the farm, including buildings, fences, and water supply. Conservative market values should be used, and not high speculative prices or low assessed valuations. When values are too high or too low the results are of little use in analyzing the farm business. If the farm is mortgaged, no account of this is necessary, as the total amount of capital used in conducting the farm business is necessary in determining the year's profits, regardless of whether or not a part of this capital is borrowed. Space is also provided in this blank for recording the value of the buildings, fences, drains, etc., at the beginning and end of the year, the value of improvements made during the year, the value of property sold or salvaged, depreciation charges, and expenses for repairs. Ordinarily it is not necessary to inventory the fences, drains, etc., as the annual repair charge will usually care for these. In most instances it will therefore be found more practical to carry through the inventories only the building valuations. Labor expended in the construction of new buildings, tile drains, or other improvements, should be included with the expense for materials under the proper headings in the real estate and improvements record, and should not be entered under

labor in the current expenses, page 35. Both repairs and depreciation are legitimate expenses in conducting a farm business. The essential point is that in arriving at a fair charge for either item, both must be considered. On one farm the improvements may be kept in first-class repair, in which case the depreciation charges will be low and the repair charge high, while the reverse may be true on another farm. The amount chargeable for a given year as a depreciation expense and as a repair expense does not depend so much upon the actual outlay for the one year as it does upon the practice over a period of years. For this reason space is provided under "repair expenses" for recording both the repair expenses for that year and the average, or what is normally expended for repairs. The expense for depreciation may be derived either by the inventory method—that is, by adding to the value at beginning of the year the value of improvements or new equipment added during the year, and subtracting from the sum the value at end of year plus value of property sold or salvaged—or on the basis of the years of remaining life. The years of remaining life basis has been found very satisfactory for many farms.

In computing the farmer's income it is not necessary to include in the farm summary expenditures for improvements (blank form, p. 36), because if they are included at all they appear both in the expense items and in the inventory items showing an increase, so that the entries cancel each other in the final calculations. The record of such improvements may therefore be treated as a memorandum and the value of such investments will appear as additional capital for the following year's business.

Live stock.—The investment in live stock is found in the live-stock record blank form, pages 32 and 33. The method of arriving at this is explained on page 8.

Machinery and equipment.—The blank form on page 37 is designed for recording the investment and outlay in machinery and equipment. The value stated for each item should be a fair price for it as compared with a new machine, according to its condition at the date of the record. Space is provided for recording values at the beginning of the year, value of purchases, value of sales, value at end of the year, depreciation charges, and value of repairs. With this information at hand, when it is desired to make a study of machinery in detail, depreciation charges may be determined either through the method of taking the difference between value at beginning of the year plus purchases, and value at end of the year plus sales or salvage, or on the basis of the years of remaining life of the machinery. However, it is not of sufficient importance to make such detailed study in the farm business analysis of many farms, and an inventory

for the beginning of the year, the purchases, sales or salvage, depreciation, and repairs will be sufficient.

Feed and supplies.—The quantity and value of feed and supplies on hand at the beginning and at the end of the year is important, as any increase or decrease in this represents a gain or loss (p. 36). The importance of this record to the business as a whole will vary according to the time the farm year begins. Thus, if it begins on April 1, ordinarily only enough roughage or grain will be on hand to last until the new crops are harvested. As previously stated, grains or hay held for sale are not included with those held for feeding purposes. The reason for accounting for these items of feed and supplies is that they form a part of the farm investment, and also represent an increased or decreased item of income in the year's business.

Cash.—The item of "cash to run the farm" should represent the average amount of money the farmer has on hand during the year for the purpose of paying current farm expenses; in other words, the average of his checking account above money used for personal and household expenses. This varies, not only from farm to farm but with the type of farming as well, as a dairy farm may be returning an income every month of the year, while a cotton or tobacco farm may return most of the year's income within one season of the year. The amount of cash necessary to run the business will range from \$100 to \$1,000 on most farms.

FARM SUMMARY.

The blank form on page 38 is for a summary of the farm business. The items for this summary are taken from the totals in the preceding forms, as follows:

Investment.—In arriving at the amount of capital invested in the year's business, use either the average of the investment at the beginning and at the end of the farm year, or simply the investment at the beginning of the year, whichever more nearly represents the true capital invested in the year's business. The conditions on the individual farm should govern this. If real estate improvements are made, additional equipment is purchased, or additional live stock are added early in the year and used in the year's business, then the average of the investment at the beginning and end of the farm year should be used. If such changes in investment are made late in the year, then the amount at the beginning of the year will probably more nearly represent the capital in that year's business. For the investment in real estate, calculate and transfer from page 36, for live stock, from pages 32 and 33, for machinery and equipment, from page 37, and for feed and supplies, from page 36. Also insert the amount of cash used to run the farm. The total of these five items represents the entire farm investment on which interest should be charged.

FACTORS AFFECTING FARM PROFITS
A STUDY OF 4244 FARMS IN 12 AREAS

THE BARS SHOW THE PER CENT OF THE AVERAGE LABOR INCOME OF THE AREA FOR EACH

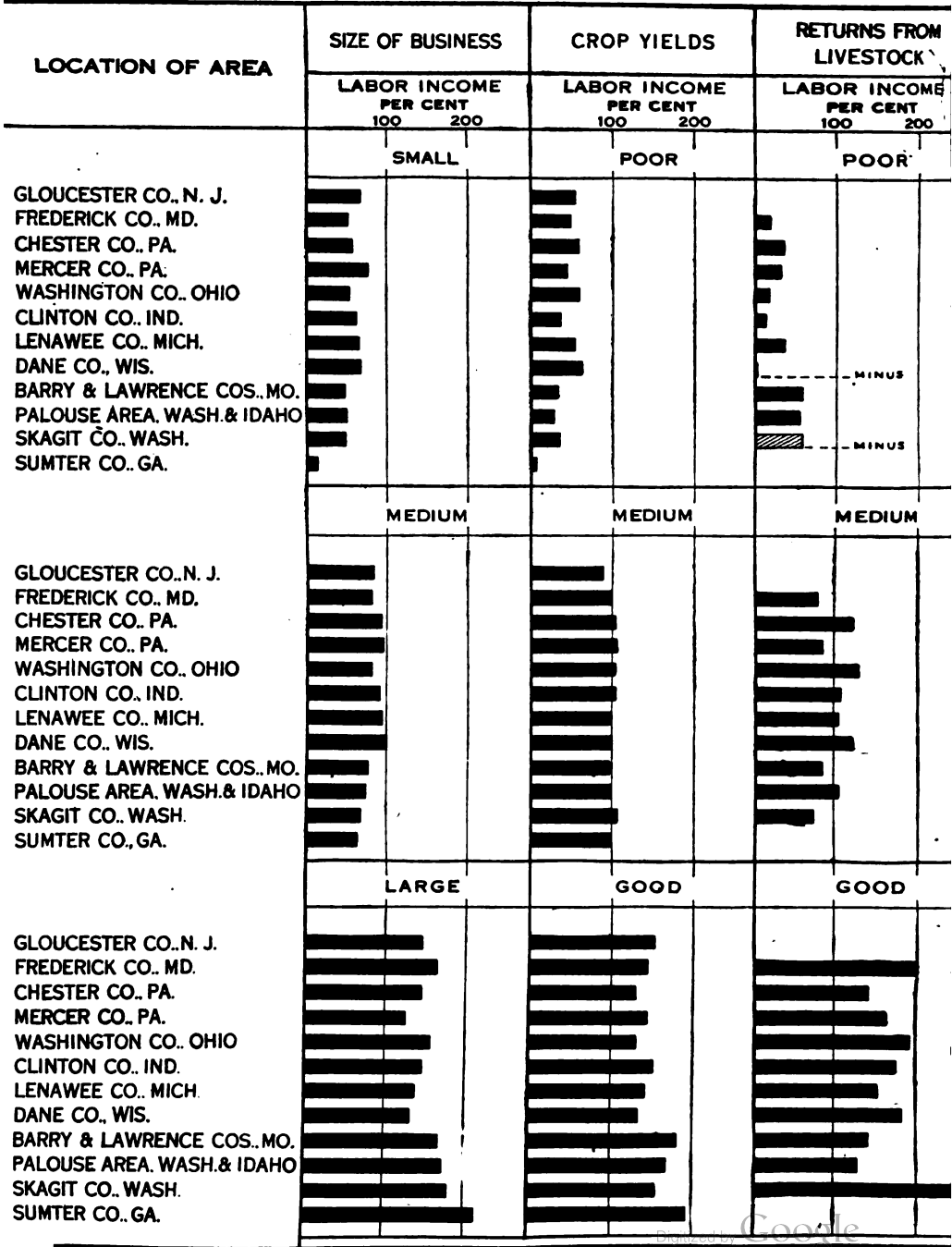
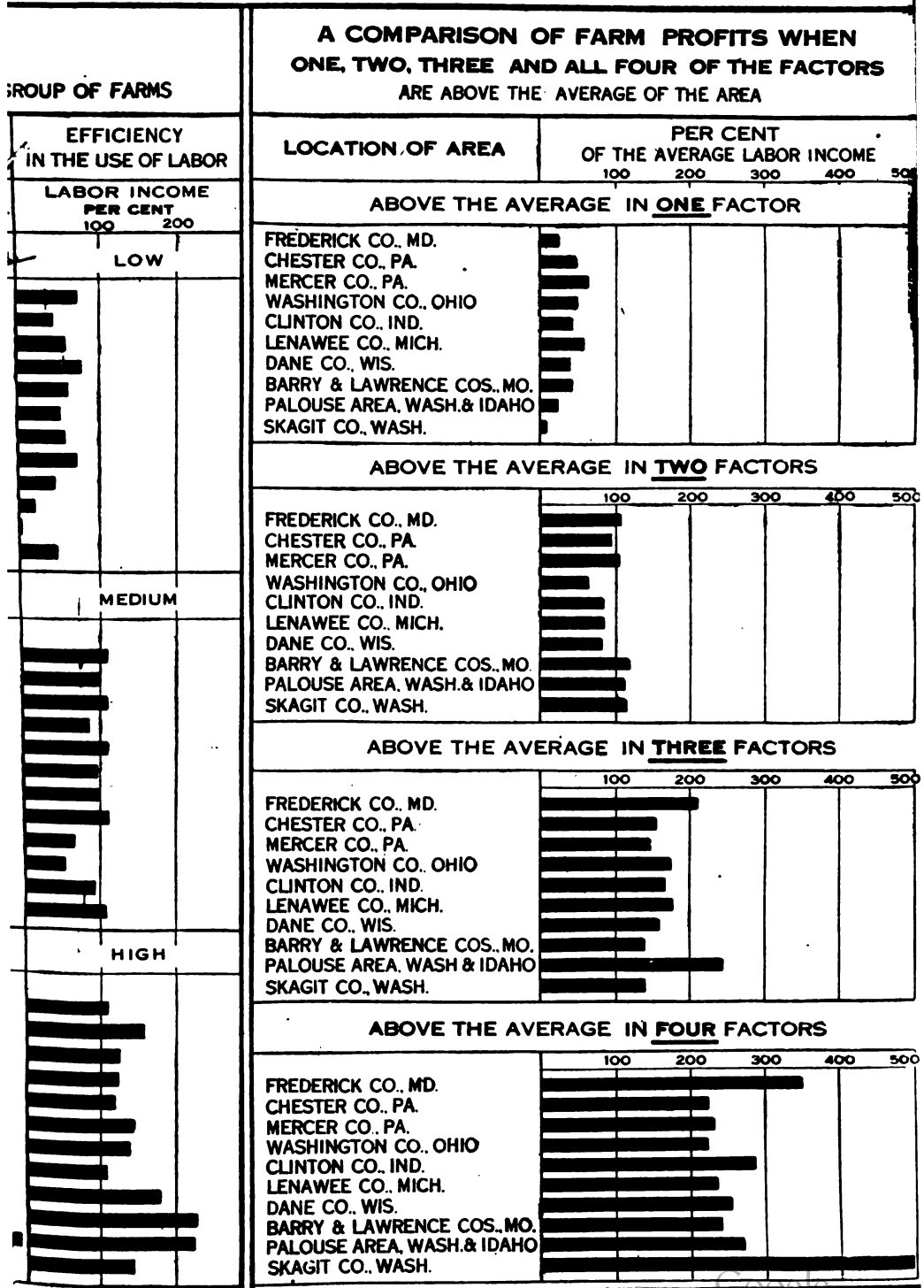


FIG. 1.—Factors affecting



Receipts.—Under receipts enter the totals for crop sales from page 31, for live stock net increase from page 34, for receipts from other sources, from page 34, and for the increase, if any, in feed and supplies, from page 36. The sum of these four groups represents the total of the farm receipts.

Expenses.—Under expenses, enter the totals for current expenses from page 35, for unpaid family labor (compute this figure as explained on page 10), for live stock net decrease, if any, from page 34, for depreciation of buildings and machinery from pages 36 and 37, and for decrease in feed and supplies, if any, from page 36. The sum of these represents the total farm expenses.

Farm income.—Subtract the total expenses from the total receipts and the result represents the farm income, which is the money received for the use of the capital and pay for the operator's labor.

Labor income.—Capital has an earning power which at least equals the current rate of interest on well-secured farm loans. Interest at this rate, deducted from the farm income, gives the farmer's labor income.

The labor income represents the amount of money the farmer has left after paying all business expenses of the farm and deducting interest on the money invested in the farm business. In addition to the labor income the farmer has the use of the farmhouse, and the products that are furnished by the farm toward his living, such as fruit, garden vegetables, dairy products, and fuel.

The difference between receipts and expenses, which represents the farm income, will not necessarily correspond to the money on hand or in the bank, as personal and living expenses have to be paid out of this amount. Furthermore, in the case of farmers having mortgages or other debts, the interest on these, as well as any principal paid, must come out of the farm income. Therefore, the record of the farm business may show a fairly large difference between the receipts and expenses, and yet the farmer may not have the cash to show for it at the end of the year, owing to the fact that the funds have been spent for living or for personal uses or have been put into other investments, such as life insurance or paying off the mortgage. The object of this record is to analyze the farm business; that is, to ascertain how much the farmer makes, not how much he actually saves. Having learned what the farm is returning, the responsibility rests with the farmer as to how much he spends personally or uses in other ways. For convenience in finding the net worth at the beginning and end of the farm year a blank form is provided on page 39.

Per cent received on investment.—Another way of expressing farm profits is that of allowing the farmer the value of his year's work as an expense and finding the per cent return upon investment after this is paid. For many farms, and especially those where prac-

tically all the labor is hired, the per cent returned upon investment may be the most satisfactory way of indicating farm profits. For determining this figure subtract the value of the farmer's own labor from the farm income and divide the result by the capital invested.

The value of the farmer's own labor is an allowance for the services of the farmer for labor and supervision at the rate at which he would have to pay another man to take his place. This is exclusive of farm dwelling and farm products used by his family.

Farm supplies for family use.—As previously stated, the blanks have been designed to record, in addition to the financial analysis, the amount and value of farm supplies used by the family. In carrying this to the summary, add the values shown under the crop record, page 31, live-stock record, pages 32 and 33, live-stock products, page 34, and other sources, page 34.

Statement of net worth.—In addition to the analysis of the year's farm business, it is of interest and value to prepare a statement of net worth, or balance sheet, to show the financial worth at a given time. The net worth represents the difference between the resources, which include all property owned by you and owing to you, and the liabilities, which include all amounts owed by you to some one else. The blank form on page 39 is designed for computing the net worth, both at the beginning and end of the year. The difference between the total net worth for these periods will represent the increased or decreased net worth for the year. This should not be hard to compute, as most of the figures may be carried forward from other forms as indicated. From the standpoint of borrowing capital, the net worth statement in addition to the year's business analysis is very important. The analysis of the year's business shows what has been accomplished through the year's farming operations. The net worth statement shows the value of all the farmer's property, and how much the farmer got ahead during the year.

FACTORS AFFECTING FARM PROFITS.

There are a number of factors which materially affect success in the organization and management of farms. Some are of greater importance than others, some may be disregarded without serious consequences; but as a rule the profits derived from farming depend very largely upon the extent to which certain essential features of organization and management have been adopted and adhered to.

TYPE OF FARMING.

The first consideration in farming is the type to be followed. The type of farming followed in any given case must be adapted to soil, climatic, and labor conditions, and especially to local conditions with

reference to markets and market facilities, as well as to the business conditions existing on the individual farm.

Profits in farming are greatly affected from year to year by conditions over which the farmer has little or no control. Such conditions are numerous, but probably the most important of these in most regions are the nature of the soil and the variation from year to year in weather conditions. There are other conditions which one man alone can little control but which require the cooperation of an entire community for best results, such as maintaining and improving public roads and public schools, or other social, educational, and economic phases of farm development.

There is also another group of factors affecting farm profits over which the individual farmer may have nearly entire control. From a study of these factors it is usually possible to determine both the good points and the deficiencies in a system of farming, and steps for improvement may be taken accordingly, with some assurance of their resulting in a better income. On a majority of farms success is primarily dependent upon four important factors. These are, (1) size of business, (2) yield of crops, (3) returns from live stock, (4) efficiency of labor. Many other factors have their influence, and must not be overlooked on a given farm; for instance, the wise expenditure of capital is very important. Overcapitalization in the way of paying too much for land, having too many or too expensive buildings, too much machinery, too high-priced work stock, etc., are very important, and at the same time a farm must be efficiently equipped. Again, in obtaining a good return from live stock the efficiency in feeding is very important. Farm management studies show, however, that the farmer whose business is efficient in the four factors outlined is generally successful. The farms that excel in none of these respects usually fail. Those deficient in one or two may succeed, but their chances of success are greatly lessened.

SIZE OF FARM BUSINESS.

In comparing farms with respect to size or volume of business, some of the more important factors to be considered are size of farm, acres in crops, the amount of live stock carried, the amount of capital invested and amount of labor required in operating the farm. On farms where one enterprise predominates, such as a specialized cotton, fruit, or dairy farm, the best measure of size of business may be the acres in cotton, acres in fruit, or number of cows. The amount of labor required in operating the farm may be used to good advantage in comparing farms of different types. Twenty acres of truck crops may, under suitable conditions, equal 200 acres of grain, hay and general live stock, both as to labor required and income received.

The approximate amount of labor required to raise some of the more important crops and care for the live stock is shown in Table I, which is based on the labor data obtained in practically all the enterprise studies thus far conducted by the Office of Farm Management, covering thousands of farms.

A work day represents 10 hours of labor. It requires on the average 10 hours of man labor and 10 hours of horse labor to cut and store an acre of hay per cutting. Therefore, an acre of hay on the average represents the work of one man and one horse for one day. The amount of labor required on other enterprises varies considerably from that for hay. Of course, innumerable factors influence the time required for most farm operations, but the results shown in this table approximate standards for average conditions in many areas. These, or such modifications of them as local experience may render advisable, may be used in working out the amount of both man and horse labor required for the productive enterprises on a given farm.

TABLE I.—*Approximate days of work required for the production of crops and in caring for live stock.*¹

[A work day is 10 hours of man or horse labor.]

Operations.	Number of work days (10 hours each).		Operations.	Number of work days (10 hours each).	
	Man labor.	Horse labor.		Man labor.	Horse labor.
Production of crops (per acre):			Production of crops (per acre)—Con.		
Timothy, alfalfa and clover hay, per cutting.....	1	1	Onions, Ohio, grown from seed (sold in bunches).....	149	10
Oats, wheat, barley, rye, buckwheat, and millet.....	2	3	Tomatoes, Northern States.....	15	11
Corn husked from standing stalks.....	2	4.5	Tomatoes, Florida.....	17	7
Corn husked from shock, or for silo.....	5	5.5	Cucumbers, Florida.....	32	10
Corn for silo, Central States.....	3	5.5	String beans, Florida.....	22	7
Corn husked, Southern States.....	4	4	Radishes, Ohio (sold in bunches).....	45	5
Sorghum cut for hay.....	3	3	Beets and carrots, Ohio, (sold in bunches).....	82	8
Irish potatoes, Northern States.....	11	10	Strawberries, Florida.....	74	9
Irish potatoes, Southern States.....	13	7	Citrus Fruits, Southern States ²	10	7
Sweet potatoes.....	10	5	Apples.....	15	5
Sugar beets ³	6	10	Caring for live stock (per year, except feeding steers and feeding sheep):		
Sugar cane for sirup, Georgia.....	16	7	Horses, corn-belt States.....	8	.75
Tobacco, Kentucky.....	35	8	Horses, Eastern States.....	12	.75
Cotton.....	13	6	Dairy cows.....	18	2
Peanuts (harvested), Georgia.....	5	3	Young stock, cattle, colts, etc.....	2.5	.2
Peanuts (hogged off), Georgia.....	3	2	20 Feeding steers per month.....	2	1.5
Watermelons, Georgia and Florida.....	5	4	10 hogs, corn-belt States.....	10	2
Field Beans.....	4	5.5	10 hogs, Eastern States.....	20	2
Rice, Louisiana, Arkansas and Texas.....	3.5	5.5	10 brood sows and raising pigs to weaning.....	30	5
Cabbage, Northern States.....	13	12	100 Ewes.....	50	5
Cabbage, Southern States.....	20	8	100 Feeding sheep, yard lots, per month.....	3.5	3
Onions, Texas (sold by crate).....	68	14	100 Chickens (well cared for).....	27	2
Onions, Ohio, grown from sets (sold in bunches).....	93	10			

¹ Acknowledgment is due to the following, who furnished some of the material contained in Table I: Messrs. L. A. Moorhouse, J. S. Ball, R. C. Wilcox, W. C. Funk, Rex E. Willard, Frank Montgomery, J. H. Arnold, M. R. Cooper, M. A. Crosby, E. S. Haskell, and G. H. Miller.

² Does not include contract labor.

³ Exclusive of picking, packing and hauling of fruit.

In Table II¹ the farm profits for small, medium, and large-sized business are shown for a number of areas. The farms are divided in size-groups on the basis of the measure which seemed to indicate best the size of business for each area under study. Whether the chance of receiving a good income in these areas is best in operating a small business, a medium-sized business, or a large business is answered in this table.

TABLE II.—*Size of business.*

Areas.	Number of farms.	Labor income. Average of farms with—			Per cent return on investment. Average of farms with—		
		Small business.	Medium business.	Large business.	Small business.	Medium business.	Large business.
Gloucester County, N. J.	125	\$686	\$867	\$1,479	7.8	8.6	11.2
Frederick County, Md.	150	189	304	611	2.4	4.6	5.8
Chester County, Pa.	502	475	816	1,242	7.0	9.2	10.4
Mercer County, Pa.	349	221	282	354	2.6	4.1	4.9
Washington County, Ohio.	25	148	228	434	1.9	3.4	5.8
Clinton County, Ind.	100	342	518	828	5.0	5.6	5.7
Lenawee County, Mich.	453	340	501	725	4.3	6.1	6.2
Dane County, Wis.	60	278	408	512	3.1	4.5	4.9
Tama County, Iowa.	210	913	1,587	1,837	4.6	5.7	5.6
Warren County, Iowa.	184	555	431	918	3.5	3.2	4.6
Barry and Lawrence Counties, Mo.	244	180	291	628	3.2	5.1	7.4
Palouse area, Washington and Idaho.	246	221	328	756	5.4	6.5	7.4
Skagit County, Wash.	202	66	94	244	2.2	3.2	5.2
Sumter County, Ga.	280	174	741	2,435	5.5	8.9	9.9
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Many farmers realize but meager incomes because their business is small. Such men often feel that their farm business is sufficiently large to keep them busy the entire year, when, as a matter of fact, the actual results accomplished represent less than a half year's work. An acre of hay normally requires 8 to 10 hours of man labor, or approximately 1 day's work for each cutting; an acre of wheat, 15 to 20 hours; an acre of potatoes, 80 to 110 hours; caring for and feeding a dairy cow, 150 to 200 hours per year. Only about 250 to 275 days are actually available for productive work. Much time is lost in doing jobs about the farm which take time, but really count for little. A farmer may keep busy the whole year, but if he has accomplished during that time only such work as should normally be done in 200 days his wages will be in proportion. A large volume of business may be done on a farm of few acres, while only a small business may be conducted on a poorly managed farm of much larger

¹ For the study shown in Tables II, III, IV, and V the farms for each area were arranged into three groups. One-third of the farms for each area are, therefore, represented in the lowest group, one-third in the medium, and one-third in the highest group. Extra space is provided in each of these tables for adding the results in other areas.

acreage. Without reasonable size of business there is little opportunity for a satisfactory profit in farming.¹

Ways of increasing the size of the farm business.—There are a number of ways of increasing the size of the farm business, some of which are:

1. Buying or renting more land. Farmers owning or renting small farms often rent additional land adjoining. This permits the use of a larger area with comparatively little additional capital.

2. Growing crops requiring more labor; that is, following a more intensive form of farming. One hundred acres devoted to corn, oats, wheat, etc., which may not be sufficient to keep two men busy, can easily be increased to a full two-man farm by the addition of a few acres of such crops as sugar beets, potatoes, or fruit, depending upon the market demand. Many persons have made the mistake of buying a small area, with the intention of following an intensive type of agriculture in localities where there is no market for the products of such farming. The fact that land is adapted to truck crops is not sufficient justification for attempting to grow them. There must be the possibility of disposing of the products at remunerative prices.

3. The addition of more livestock, sometimes even beyond the point where the farm itself will support them. This is a practice followed by a large number of dairy farmers in some of the Eastern States. This necessitates the purchase of feed where the nature of the land is such as to prohibit the raising of grain as cheaply as it can be bought, or where the production of roughages and succulent feeds is more profitable than grain growing. Loss is liable to result in this undertaking unless the additional animals are of high producing quality. This is the one way open to many farmers whose business

¹ The number of farms, average size, labor income, year or years of study, and investigators in charge of the studies used in Tables II, III, IV, V, and VI are as follows: Gloucester County, N. J., 125 farms, average size, 81 acres, average labor income, \$1,013, 3 years, 1914-1916, by G. A. Billings; Frederick County, Md., 150 farms, 140 acres, \$368 labor income, 1915, by H. A. Miller; Chester County, Pa., 502 farms, 94 acres, \$845 labor income, 1911, by H. M. Dixon; Mercer County, Pa., 349 farms, 101 acres, \$285 labor income, 1916, by Earl D. Strait; Washington County, Ohio, 25 farms, average size, 158 acres, average labor income, \$272, 7 years, 1912-1918, by H. W. Hawthorne; Clinton County, Ind., 100 farms, 126 acres, \$558 average labor income, 7 years, 1910, by E. H. Thomson, 1913-1918, by H. M. Dixon; Lenawee County, Mich., 453 farms, 112 acres, \$522 labor income, 1911, by H. M. Dixon; Dane County, Wis., 60 farms, average size, 148 acres, average labor income, \$407, 5 years, 1913-1917, by H. C. Taylor; Tama County, Iowa, 210 farms, average size, 220 acres, average labor income, \$1,378, 1918, by E. D. Strait; Warren County, Iowa, 184 farms, average size, 177 acres, average labor income, \$637, by E. D. Strait, 1918; Barry and Lawrence Counties, Mo., 244 farms, 122 acres, \$371 labor income, 1914, by W. J. Spillman and F. H. Branch; Palouse area, Washington and Idaho, 246 farms, 319 acres, average labor income, \$436, 1914, by L. W. Fluharty; Skagit County, Wash., 202 farms, 46 acres, \$152 labor income, 1915, by Harry Thompson and Earl D. Strait; Sumter County, Ga., 268 white owner farms, 418 acres, \$470 labor income, 1913, and 280 white owner farms, 432 acres, \$1,817 labor income, 1918, by H. M. Dixon and H. W. Hawthorne.

Cooperation: Mercer County, Pa., survey in cooperation with the Pennsylvania State Agricultural College; Washington County, Ohio, survey for the years 1912 and 1913, in cooperation with the Ohio Agricultural Experiment Station; Dane County, Wis., survey in cooperation with the Wisconsin State Agricultural College; Tama and Warren Counties, Iowa, surveys in cooperation with the Iowa Agricultural College; Sumter County, Ga., survey, 1918, in cooperation with the Georgia Agricultural College.

would otherwise be too small to give them a good living. The success of many farms is in large measure dependent upon the number of high-quality cows or other live stock that can be kept.

4. By performing work outside the farm, such as teaming or working at lumbering during the winter. In many farming regions the opportunity for this source of income is very limited.

No one realizes better than the farmer that as a rule no phenomenal profits can be expected, and persons going into farming as a business should consider this fact. Agriculture is a good life work; it will pay wages and moderate returns on investment, provided both capital and labor are wisely expended. Success is most difficult to attain, however, unless the farm business is large enough to permit the efficient use of capital, labor, and managerial ability.

YIELD OF CROPS.¹

Crop yields greatly influence farm profits. Some farmers make fair profits with low yields because some other phase of the farm business is sufficiently developed to offset the poor yields, but it is doubtless true that these same farmers could make more money with higher yields. Profits increase at least until yields are obtained considerably above the average for the region, but beyond this limit very high yields are liable to be obtained at the expense of farm profits.

¹ As a measure of the yields of crops either the yield per acre of each crop may be used, or the yields of all the crops grown may be reduced to a percentage comparative basis by the method shown, which is commonly known and referred to as "crop index." On farms where one crop predominates, the yield of that crop may be the best index of good yields, but where a number of crops are grown the use of the crop index will be found of value in making comparisons.

The crop index which is used as a measure of the yields on a given farm, is found as follows: Suppose a given farm produces—

500 bushels of corn on.....	10 acres.
200 bushels of wheat on.....	10 acres.
25 tons of hay on.....	20 acres.

Total.....40 acres.

Suppose, further, the average yields in the locality are such that, on the average, farmers produce—

500 bushels of corn on.....	7.7 acres (65 bushels per acre).
200 bushels of wheat on.....	8.0 acres (25 bushels per acre).
25 tons of hay on.....	16.7 acres (1.5 tons per acre).

Total.....32.4 acres.

The crop index of the farm in question is now found by dividing 32.4 by 40; that is, by dividing the acres required with average yields by the acres required on this farm to produce the given quantities of these products. In this case the crop index is 0.81. This means that the yields on this farm are approximately 81 per cent of the average of the community.

TABLE III.—Crop yields.

Area.	No. of farms.	Labor income. Average of farms with—			Per cent return on investment. Average of farms with—		
		Poor yields.	Medium yields.	Good yields.	Poor yields.	Medium yields.	Good yields.
Gloucester County, N. J.	125	\$515	\$923	\$1,609	4.5	8.7	14.5
Frederick County, Md.	150	181	371	551	3.6	4.7	5.5
Chester County, Pa.	502	508	892	1,129	6.1	9.1	11.3
Mercer County, Pa.	349	129	303	423	1.4	4.5	5.8
Washington County, Ohio.	25	165	284	364	2.0	3.9	5.2
Clinton County, Ind.	100	198	583	890	3.9	5.5	6.9
Lenawee County, Mich.	453	284	517	785	3.8	5.7	7.1
Dane County, Wis.	60	266	407	561	3.6	4.0	4.9
Tama County, Iowa.	210	676	1,309	2,158	4.2	5.3	6.2
Warren County, Iowa.	184	233	725	936	2.5	4.0	4.8
Barry and Lawrence Counties, Mo.	244	120	355	682	2.2	5.4	8.6
Palouse Area, Washington and Idaho.	246	119	434	750	5.1	6.5	7.8
Skagit County, Wash.	202	49	147	214	2.7	3.9	4.1
Sumter County, Ga.	280	57	1,124	2,230	4.2	8.5	11.5
.....							
.....							
.....							
.....							
.....							

In Table III the farms for the various areas are placed in groups of those returning low yields, medium yields, and high yields, with the labor income and per cent return on investment shown for each group. These results show clearly the importance of obtaining good crop yields if they are not obtained at too great an expense. Other factors undoubtedly contributed toward making profits the greater on the farms with higher yields, but the fact that all areas show the same general results is indicative of the importance of this factor.

RETURNS FROM LIVE STOCK.

On farms where live stock is an important enterprise, the quality of the stock is very important. On a majority of farms, except in the South and certain of the Western States, more of the crops are fed to live stock than are sold direct. On many farms the animals are the market for the crops, hence the production of these is a most important factor in farm profits. The best of corn and hay crops will count for little when fed to animals that make returns below the market prices for these crops. On the other hand, good live stock on the individual farms may not be profitable if not fed and cared for economically.

In Table IV is shown the effect of the returns from live stock upon income when the farms where live stock is an important enterprise are arranged in three groups according to whether they show poor, medium, or good production. The returns from live stock are meas-

ured by the amount and value of product returned per animal, and the table shows that the returns from live stock constitute an important factor.

TABLE IV.—Returns from live stock.¹

Area.	Number of farms.	Labor income. Average of farms with—			Per cent return on investment. Average of farms with—		
		Poor live-stock returns.	Medium live-stock returns.	Good live-stock returns.	Poor live-stock returns.	Medium live-stock returns.	Good live-stock returns.
Frederick County, Md.....	150	\$76	\$285	\$737	2.8	4.5	6.5
Chester County, Pa.....	502	413	912	1,215	5.0	9.6	12.0
Mercer County, Pa.....	319	136	244	473	1.4	3.9	6.3
Washington County, Ohio.....	25	54	243	528	.2	3.5	7.6
Clinton County, Ind.....	100	82	605	995	3.6	5.7	6.9
Lenawee County, Mich.....	433	208	543	817	2.8	5.9	7.8
Dane County, Wis.....	60	—9	500	740	1.7	4.7	6.2
Tama County, Iowa.....	210	726	1,271	2,137	4.2	4.9	6.6
Warren County, Iowa.....	194	—70	631	1,339	2.0	3.8	5.5
Barry and Lawrence Counties, Mo.....	244	223	317	541	3.2	4.5	7.7
Pelouse area, Washington and Idaho.....	246	250	463	577	5.5	6.5	7.2
Skagit County, Wash.....	246	—79	100	303	1.7	3.8	5.3
.....							
.....							
.....							
.....							
.....							

¹ Gloucester County, N. J., and Sumter County, Ga., areas are not included in this table because of the relative unimportance of the live-stock industry in these areas.

EFFICIENCY IN THE USE OF LABOR.

The exceedingly diverse nature of farm operations makes wide opportunity for inefficiency to enter into their performance. In a factory with modern machinery a man is expected to do a certain amount of work, and in many instances the machine sets the pace for him. Generally the worker on the farm must be his own boss and must set his own pace. He must also work under most adverse weather conditions at certain times. Often a great deal of work must be devoted to things which add little or nothing to the profits of the business. It requires twice as much time for some men as compared with others to do a certain kind of work. Work may also be so organized that a given amount of effort accomplishes more than the average. The efficient use of horse labor is also very important and bears a close relation to size of business. On the one-man farm the horses must necessarily be unemployed every time the farmer finds it necessary to do work not requiring horse labor. On the larger farms the work can be so arranged as to have one man keep the horses busy while others attend to the work where horse labor is not needed.

In Table V is shown the effect upon farm profits of a low, medium, and high return for man labor. The common basis used for comparing efficiency in the use of labor is that of crop acres per man, and

this is a satisfactory measure providing the farms are of the same general type. Where farms vary in type a good measure is the number of days of productive labor per man. Inefficiency in the use of labor may be due to lack of opportunity, indifference of the operator, or many other factors. Whatever the reasons, the results show that with a low return per man the profits will usually be correspondingly small.

TABLE V.—*Efficiency in the use of labor.*

Area.	Number of farms.	Labor income. Average of farms with—			Per cent return on investment. Average of farms with—		
		Low labor returns.	Medium labor returns.	High labor returns.	Low labor returns.	Medium labor returns.	High labor returns.
Gloucester County, N. J.....	125	\$773	\$1,120	\$1,149	7.4	10.2	10.1
Frederick County, Md.....	150	174	362	587	3.6	4.5	5.8
Chester County, Pa.....	502	530	936	1,073	6.6	9.5	10.5
Mercer County, Pa.....	349	239	256	361	3.0	3.9	4.6
Washington County, Ohio.....	25	181	305	332	2.0	4.5	4.7
Clinton County, Ind.....	100	316	550	812	4.6	5.7	6.0
Lenawee County, Mich.....	453	313	520	733	4.1	5.6	6.9
Dane County, Wis.....	60	312	457	455	3.6	4.4	4.5
Tama County, Iowa.....	210	722	1,380	2,061	4.2	5.4	6.0
Warren County, Iowa.....	194	373	647	885	2.5	4.1	4.8
Barry and Lawrence Counties, Mo.....	244	182	257	666	3.4	4.2	8.0
Palouse area, Washington and Idaho.....	246	95	242	944	4.8	6.4	8.0
Skagit County, Wash.....	202	4	131	291	2.0	3.8	5.1
Sumter County, Ga.....	280	532	1,224	1,675	5.0	8.8	10.5
.....							
.....							
.....							
.....							
.....							

THE EFFECT OF ALL FOUR FACTORS.

The results shown in Tables II, III, IV, and V relative to the effect of size of business, yield of crops, production of live stock, and efficiency in the use of labor, are evidence that no one of these is the determining factor for success. Size of business is very important, but a large business conducted without attention to these other factors will probably result in a loss. In Table VI is shown the effect upon profits of having one, two, three, or all four factors (size of business, crop yields, production of live stock, or efficiency in the use of labor) better than the average of the region. Those with two of these factors better than the average make more than those with only one, and those with all four factors above the average far excel all others in profits. Only a small proportion, usually less than 10 per cent, of the farms are better than the average in all four respects, while from 20 to 30 per cent of the farms in each area have only one factor better than the average of the region, and from 9 to 21 per cent of the farms are below the average in all four factors. (Table VI.)

TABLE VI.—A comparison of farm profits when one, two, three and all four of the factors (size of business, crop yields, returns from live stock, and efficiency in the use of labor) are above the average of the region.¹

Area.	Number of farms.	Farms above the average of the region in—							
		One factor.		Two factors.		Three factors.		Four factors.	
		Per cent of total farms.	Average labor income.	Per cent of total farms.	Average labor income.	Per cent of total farms.	Average labor income.	Per cent of total farms.	Average labor income.
Frederick County, Md.	150	28	\$94	39	\$400	19	\$774	4	\$1,288
Chester County, Pa.	502	26	432	38	827	21	1,339	7	1,907
Mercer County, Pa.	349	28	190	35	304	19	424	7	665
Washington County, Ohio.	25	31	137	21	176	20	480	14	611
Clinton County, Ind.	100	27	252	29	496	22	943	9	1,606
Lenawee County, Mich.	453	24	321	36	467	20	930	7	1,241
Dane County, Wis.	60	24	165	35	345	25	655	6	1,044
Tama County, Iowa.	210	29	512	30	1,352	25	2,480	5	3,700
Warren County, Iowa.	184	28	351	36	629	16	1,339	8	1,662
Barry and Lawrence Counties, Mo.	244	22	168	26	450	18	527	13	898
Palouse area, Washington and Idaho.	216	29	117	33	501	15	1,069	7	1,186
Skagit County, Wash.	202	27	15	35	160	16	190	8	673
.....									
.....									
.....									
.....									
.....									

¹ Gloucester County, N. J., and Sumter County, Ga., areas not included in this table because of the relative unimportance of the live-stock industry in these areas.

A well-balanced farm business is nearly always profitable. The farms that are as good or better than the average of their community in all four of the factors here mentioned seldom fail to make a good profit. Thus, if a farm is devoted to a type of farming adapted to its conditions, if it is as good or better than the average in size of business, yield of crops, production of live stock, and efficiency in the use of labor, and is adequately and economically equipped, it is almost certain to be profitable. The weakest factor is the one that needs attention in improving the business. If the quality of the live stock is high, greater improvement in the farm business can usually be obtained by devoting attention to developing the size of the business or sale of cash crops, or increasing labor efficiency, rather than by further improving the quality of live stock.

Figure 1 (pp. 14-15) illustrates graphically the data presented in Tables II, III, IV, V, and VI. Instead of showing the average labor income of the groups of farms in each area with small, medium, and large sized business, with poor, medium, and good crop yields and live-stock returns, and with low, medium, and high labor efficiency, the chart shows the percentage the average labor income of each group is of the average of all farms of the area. The groups with small sized business returned only about 55 per cent of the average labor

income of the area, while the groups with large sized business returned 158 per cent of the average. The groups with poor crop yields returned 44 per cent of the average labor income of the area, while those with good crop yields returned 156 per cent. The groups having poor returns from live stock returned only 25 per cent of the average labor income of the area, while those with good returns from live stock returned 179 per cent. The groups of farms low in labor efficiency returned 54 per cent of the average labor income of the area, while those high in labor efficiency returned an average labor income equal to 155 per cent of the average of the area.

By a little closer study of the chart something of the relative importance of these factors in each area may be determined. For example, in areas having the greater part of the receipts from live stock, there is a greater difference between the average labor income of the groups of farms having poor returns and good returns from live stock than between the groups having poor crop yields and good crop yields—returns from live stock being the factor of greater importance. In areas having the greater part of the receipts from the sale of crops, there is a greater difference between the average labor income of the groups of farms having poor crop yields and good crop yields than between the groups having poor returns and good returns from live stock—crop yields being the factor of greater importance. The areas in Mercer County, Pa.; Washington County, Ohio; Dane County, Wis.; and Skagit County, Wash., are predominantly live-stock areas, while those in Gloucester County, N. J.; Barry and Lawrence Counties, Mo.; Palouse area in Washington and Idaho; and Sumter County, Ga., are predominantly crop areas.

In the part of the chart showing a comparison of the profits on farms with one, two, three, or all four of the factors above the average of the area, the average labor income of the groups of farms above the average of the area in but *one* factor seldom exceeds 50 per cent of the average labor income of all farms; the groups of farms with *two* factors above the average of the area have average labor incomes around the average of those of the area as a whole. The groups of farms better than the average of the area in *three* factors have labor incomes about 75 per cent above the average of the area, while those better in all *four* factors have labor incomes 175 per cent above the average of the area. About one-fourth of all the farms were above the average of the area in only one factor, one-third in two factors, one-fifth in three factors, and less than one-tenth in all four factors.

BLANKS FOR USE IN ANALYZING THE FARM BUSINESS AND DETERMINING THE FARM INCOME.

State

County

Township

Farm year beginning

Operator

P. O. Address

Landlord

P. O. Address

Location

Miles from market

Soil type

Topography

FARM AREA.

Acres owned	Acres in crops
Acres cash rented	Acres in tillable land lying out
Acres share rented	Acres in rotation pasture
Total	Acres in permanent pasture tillable
Acres rented out	Acres in open pasture not tillable
Acres operated	Acres in woodland pastured
.....	Acres in woodland not pastured
.....	Acres in waste lands, roads, etc

CROP RECORD.

Crops.	Acres.	Yield.		Operator's sales.			Landlord's sales.			Family use.	
		Per acre.	Total.	Amount.	Price.	Value.	Amount.	Price.	Value.	Amount.	Value.
Cotton, wages.....											
Cotton, croppers.....											
Cotton seed, wages.....											
Cotton seed, croppers.....											
Corn for grain.....											
Corn fodder.....											
Corn for silage.....											
Other corn.....											
Wheat.....											
Rye.....											
Oats.....											
Barley.....											
Buckwheat.....											
Seed, clover or timothy.....											
Straw.....											
Hay, clover or timothy.....											
Alfalfa (.....cuttings).....											
Cowpea hay.....											
Soy bean hay.....											

Peanuts	
Velvet beans	
Beans	
Tobacco	
Sugar beets	
Rice	
Sugar cane	
Sorghum	
Irish potatoes	
Sweet potatoes	
Turnips	
Melons	
Tomatoes	
Cabbage	
Onions	
String beans	
Apples, bearing	
Apples, nonbearing	
Peaches	
Pears, plums, cherries	
Grapefruit	
Oranges	
Tangerines	
Berries	
Garden	
Total	

OPERATOR'S LIVE-STOCK RECORD.

Kind.	Beginning of farm year.			End of farm year.			Sales during year.			Purchases during year.			Died.	Family use.	
	Num- ber.	Price.	Value.	Num- ber.	Price.	Value.	Num- ber.	Price.	Value.	Num- ber.	Price.	Value.	Num- ber and value.	Num- ber.	Value.
Horses.....															
Mules.....															
Colts (....)¹															
Cows.....															
Heifers over 1 year.....															
Calves under 1 year (....)¹															
Bulls.....															
Steers over 1 year.....															
Ewes.....															
Lambs under 1 year (....)¹															
Brood sows.....															
Other hogs.....															
Pigs (....S....F.)¹															
.....															
Chickens.....															
Turkeys.....															
Ducks.....															
Total.....															

¹ Record number of calves, colts, lambs, and spring and fall pigs born during year.

LANDLORD'S LIVE-STOCK RECORD.

Kinds.	Beginning of farm year.			End of farm year.			Sales during year.			Purchases during year.			Died.	Family use.	
	Num-ber.	Price.	Value.	Num-ber.	Price.	Value.	Num-ber.	Price.	Value.	Num-ber.	Price.	Value.	Num-ber and value.	Num-ber.	Value.
Horses															
Mules															
Colts (....) ¹															
Cows															
Heifers over 1 year															
Calves under 1 year (....) ¹															
Bulls															
Steers over 1 year															
Ewes															
Lambs under 1 year (....) ¹															
Brood sows															
Other hogs															
Pigs (....S....F.) ¹															
Chickens															
Turkeys, ducks, geese															
Total															

¹ Record number of calves, colts, lambs, and spring and fall pigs born during year.

LIVE-STOCK PRODUCTS.

Items.	Sales.				Family use.	
	Amount.	Price.	Operator.	Landlord.	Amount.	Value.
Butter, milk, cheese . . .						
Eggs . . .						
Meat . . .						
Wool . . .						
Breeding fees . . .						
Hides . . .						
Total . . .						

LIVE-STOCK SUMMARY.

	Horses and mules.	Cattle.	Sheep.	Hogs.	Poultry.	Total live stock.
Live-stock products (p. 34) . . .						
Live stock sold (pp. 32, 33) . . .						
Livestock end of year (pp. 32, 33) . . .						
Total . . .						
Live stock purchased (p. 32) . . .						
Live stock beginning of year (pp. 32, 33) . . .						
Total . . .						
Increase ¹ . . .						
Decrease ¹ . . .						
Operator's net increase ¹ . . .						
Operator's net decrease ¹ . . .						
Landlord's net increase ¹ . . .						
Landlord's net decrease ¹ . . .						

OTHER SOURCES OF INCOME.

Items.	Receipts.				Family use.	
	Amount.	Price.	Operator.	Landlord.	Amount.	Value.
Man and team labor . . .						
Machine work . . .						
Rent—land, buildings . . .						
Sirup and sugar . . .						
Bees and honey . . .						
Lumber, wood, etc . . .						
Total . . .						

¹ If sum of stock products, stock sold, and stock at end of year is greater than sum of stock purchased and stock at the beginning of year, the difference is increase; if less, decrease.

CURRENT EXPENSES.

Items.	Operator.	Landlord.
Year hands (..... months).....		
Month hands..... (..... months).....		
Day hands..... (..... months).....		
Cotton picking, chopping (..... months).....		
Cropper labor..... (..... months).....		
Contract labor..... (..... months).....		
Board of hired labor..... (..... months).....		
Repairs, machinery (p. 37).....		
Repairs, dwelling (p. 36).....		
Repairs, tenant houses (p. 36).....		
Repairs, other buildings (p. 36).....		
Repairs, fences (p. 36).....		
Repairs, drains or terraces (p. 36).....		
Feed: Roughage.....		
Feed: Grain, etc.....		
Pasture, bedding.....		
Feed grinding, silo filling, corn shredding.....		
Milk hauling, cow testing, ice.....		
Horseshoeing.....		
Veterinary, medicines, dips, etc.....		
Breeding fees, registry fees.....		
Seeds, plants, trees.....		
Fertilizer, wage land (..... tons).....		
Fertilizer, cropper land..... (..... tons).....		
Lime (..... tons), manure (..... tons).....		
Spray material.....		
Twine.....		
Thrashing, clover hulling.....		
Baling and wire, cotton ginning.....		
Other machine work hired.....		
Fuel and oil for farm work.....		
Auto for farm use.....		
Telephone.....		
Bags, cans, crates, barrels, boxes, etc.....		
Storage, freight, commission.....		
Advertising, auctions.....		
Insurance.....		
Taxes.....		
Water tax.....		
Cash rent.....		
Interest.....		
Total.....		

REAL ESTATE AND IMPROVEMENTS.

[T=Tenant, L=Landlord.]

Items.	Value at beginning of year.	Value of improvements made during year.	Value of property sold or salvaged during year.	Value at end of year.	Depreciation charges.		Repair expenses.	
					Per cent.	Amount.	During year.	Normal.
Dwellings								
Tenant houses.....								
Other buildings.....								
Fences.....								
Drains, terraces.....								
Land clearing								
Total for operator.....								
Total for landlord.....								
		Beginning of year.	Purchased during year.	Sold during year.	End of year.			
Value operator's real estate								
Value landlord's real estate.....								

FEED AND SUPPLIES.

[T=Tenant, L=Landlord.]

Items.	Beginning of farm year.			End of farm year.		
	Amount.	Price.	Value.	Amount.	Price.	Value.
Hay						
Silage						
Corn						
Wheat						
Oats						
Cotton seed						
Seed cane.....						
Clover, grass seed						
Total for operator						
Total for landlord						
Operator's increase ¹				Decrease ¹		
Landlord's increase ¹				Decrease ¹		

¹ If value of feed and supplies at end of year is greater than at beginning the difference is "increase"; if less, "Decrease."

MACHINERY AND EQUIPMENT.

[T—Tenant, L—Landlord.]

No.	Items.	Value at beginning of year.	Value of purchases during year.	Value of sales during year.	Value at end of year.	Depreciation charges.		Value of repairs made during year.
						Per cent.	Amount.	
---	Wagons, beds, racks							
---	Buggies, carriages							
---	Sleds							
---	Stalk cutters							
---	Breaking plows							
---	Harrows							
---	Rollers, plankers							
---	Corn, cotton planters							
---	Grain drills, seeders							
---	Plantsetters							
---	Cultivators							
---	Corn, grain binders							
---	Mowers							
---	Tedders							
---	Hay rakes, loaders							
---	Hay stackers, balers							
---	Manure spreaders							
---	Fertilizer distributors							
---	Thrashers, hullers, etc							
---	Husker, etc							
---	Ensilage cutters							
---	Grain cleaners							
---	Feed grinders							
---	Sirup and sugar eq'p't.							
---	Beet, tobacco eq'p't.							
---	Potato diggers, etc							
---	Sprayers, etc							
---	Engines							
---	Tractors							
---	Autotrucks							
---	Work harness							
---	Driving harness							
---	Milking machines							
---	Other dairy equipm't.							
---	Sheep equipment							
---	Hog equipment							
---	Poultry equipment							
---	Bee equipment							
---	Other equipment							
---	Total for operator							
---	Total for landlord							

SUMMARY.

	Operator.		Landlord.	
	Item.	Total.	Item.	Total.
Investment: ¹				
Real estate (p. 36).....	-----		-----	
Live stock (pp. 32, 33).....	-----		-----	
Machinery and equipment (p. 37).....	-----		-----	
Feed and supplies (p. 36).....	-----		-----	
Cash to run farm.....	-----		-----	
Total.....	----->		----->	
Farm receipts:				
Crops (p. 31).....	-----		-----	
Live stock, increase (p. 34).....	-----		-----	
Other sources (p. 34).....	-----		-----	
Increase feed and supplies (p. 36).....	-----		-----	
Total.....	----->		----->	
Farm expenses:				
Current (p. 35).....	-----		-----	
Unpaid family labor (... mo.).....	-----		-----	
Live stock, decrease (p. 34).....	-----		-----	
Depreciation (pp. 36, 37).....	-----		-----	
Decrease feed and supplies (p. 36).....	-----		-----	
Total.....	----->		----->	
Farm income				
Interest on investment at ... per cent ² ...				
Labor income.....				
Value operator's labor (... mo.).....				
Per cent return on investment ³				
Value items for family use (pp. 31 to 34).....	----->		----->	

¹ Use average investment or that of beginning of year, whichever more-nearly represents the true capital invested in the year's business.

² Use current rate of interest on well-secured farm loans.

³ After deducting value of operator's labor from farm income.

STATEMENT OF NET WORTH.

	Beginning of farm year.	End of farm year.
RESOURCES: ¹		
All cash on hand.....		
Real estate (p. 36).....		
Livestock (pp. 32, 33).....		
Machinery (p. 37).....		
Feed and supplies (p. 36).....		
Household equipment.....		
Automobile		
Other tangible property.....		
Accounts owing to you.....		
Notes owing to you.....		
Mortgages owing to you.....		
Bonds and stocks owned.....		
Interest due you or accrued on notes, mortgages, and bonds.....		
Total resources		
LIABILITIES: ²		
Accounts owed by you.....		
Notes owed by you.....		
Mortgages owed by you.....		
Interest due or accrued and owed by you.....		
Total liabilities		
Total net worth ³		
Increase or decrease in net worth ⁴		

¹ Includes all property owned by you and owing to you

² Includes all amounts which are owed by you to some one else.

³ Subtract total liabilities from total resources.

⁴ If total net worth at the end of the year is greater than at the beginning of the year the difference is an increase; if less, a decrease.

SOME MEASURES OF SUCCESSFUL FARMS.¹

	This farm.	Average of farms of same type in locality.
SIZE OF BUSINESS: Farm area		
Crop area		
Months of man labor ²		
Number of work stock		
Number animal units ³		
Number cows		
Days of productive man labor ⁴		
INVESTMENT: Per cent of investment in real estate		
In buildings per crop acre		
In machinery per crop acre		
CROP RETURNS: ⁵		
.....		
.....		
.....		
LIVE-STOCK RETURNS: ⁶		
.....		
.....		
Returns per \$100 invested in live stock		
EFFICIENCY OF LABOR: Crop acres per man		
Crop acres per horse		
Productive work days per man		
Productive work days per horse		
Costs: Total value of farm feeds consumed by live stock ⁷		
Total value of purchased feeds consumed by live stock		
Total feed cost per animal unit		
Total value of man labor ⁸		
Per cent total expenses are of total receipts		
Per cent total feed cost is of total live-stock returns		
Net returns per \$1 of labor		
Labor cost per productive work day		
PROFITS: Labor income		
Per cent return on investment		

¹ Designed for general application; record important measures for a given farm or locality. The value of any given measure will vary with the kind of farming and section of the country.

² Add months of hired labor, p. 35, family labor, p. 38, and farmer's labor, p. 38.

³ An animal unit is used as the basis for comparing different kinds of animals and represents one mature horse, cow, or steer, or as many smaller animals as require the feed of these. Usually 2 head of young cattle or colts, 7 sheep, 14 lambs, 5 hogs, 10 pigs, or 100 chickens are each equivalent to one animal unit.

⁴ The productive days of man labor represent the number of days of labor that should ordinarily be required to care for the live stock and raise the crops. See Table 1, page 19, for approximate time required for various crops and classes of live stock and make computations for a given farm accordingly.

⁵ Record important crops and yields per acre or receipts. Crop record, pages 30, 31.

⁶ Record important measures of good live stock such as production or receipts per cow, receipts per ewe, receipts per sow, etc. Live stock and live stock products records, pp. 32, 33, and 34.

⁷ Find the value of all crops fed from crop record, pages 30, 31, plus a charge for pasture, plus or minus the difference in feed inventory, page 36.

⁸ Add value of all hired labor, p. 35, plus family labor, p. 38, plus farmer's labor, p. 38.

GRASSHOPPER CONTROL IN THE PACIFIC STATES

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FARMERS' BULLETIN 1140
UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief

Washington, D. C.

October, 1920

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THE SEVERE grasshopper infestations of recent years have made it urgently necessary to put before the farming population in many communities the most practical and efficient methods of destroying these pests. In the Pacific Coast States conditions are such that the grasshoppers are able to develop in the immense uncultivated areas and migrate to the irrigated districts, attacking the cultivated crops and doing extensive damage.

The use of the hopperdozer, the use of fire, the destruction of the eggs in the soil, driving the wingless species and nymphs into pits, and the use of poisoned bran mixture are some of the control measures that have proved efficient under western conditions. The most successful of these has been the poisoned bran mixture, which is discussed in detail on pages 8 to 11.

The following pages also outline a program for organized community action; describe the common species of grasshoppers; and discuss control on the ranges, in alfalfa fields, in orchards, vineyards, and mountain meadows, and in corn, grain, and bean fields.

GRASSHOPPER CONTROL IN THE PACIFIC STATES ¹

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GRASSHOPPER OUTBREAKS.

The natural conditions over the Western States are such that grasshopper outbreaks may be expected for many years to come, as the immense uncultivated areas of mountains, foothills, grass lands, and alfalfa fields offer many varying conditions favorable to the abundant development of one or more of the destructive species involved. The earliest outbreaks occur on the warm, sunny, dry lands and foothills. These are followed by later outbreaks appearing on the cool, damp valley soils. The nymphs appear in greatest abundance wherever the adults have massed and deposited eggs in large numbers the preceding year. This massing of grasshoppers is normal for some species, but may be influenced by the abundance of food plants or by the presence of conditions favorable to egg laying, such as dense crowns of bunch grasses, large alfalfa crowns, uncultivated gravel soils, and dry sunny hillsides.

The destructiveness of these outbreaks depends upon many factors. The early drying of range grasses in June of 1919 was in part responsible for the abundant migration in that year of destructive species to cultivated crops. Grasshopper migration from the foothills and range lands is not so marked when there is an abundance of spring rain and grasses continue green until weeds begin to grow.

¹ The studies in regard to poisoning grasshoppers were extended to deciduous fruit orchards at the request of Dr. A. L. Quaintance, in charge of Deciduous Fruit Insect Investigations, Bureau of Entomology.

Immense swarms of grasshoppers are sometimes held on the uncultivated lands because of the presence of certain weeds which are natural food plants. Cutting meadow grasses or alfalfa on severely infested fields may cause the grasshoppers to migrate to other fields or orchards. A hot wind may cause sudden migration, while cool, dark weather frequently results in considerable inactivity on the part of these pests.

FAVORABLE AND UNFAVORABLE CONDITIONS.

Dry weather favors the development of young grasshoppers, provided they have the necessary green food, and the most severe outbreaks follow a succession of comparatively dry years. Grasshoppers usually deposit their eggs on knolls, ridges, or well-drained hillsides. In the Sacramento Valley of California grasshoppers also hatch in large numbers on grass lands which sometimes are flooded by a foot or more of water in early spring. A similar condition obtains in some of the valleys of the Sierra Nevada Mountains, where the meadows are flooded after the snows melt. Alternate freezing and thawing, or even severe drying after an early fall rain, appears to disturb many of the egg pods sufficiently to admit moisture and destroy the eggs. A heavy frost is fatal to many nymphs. Cloudy weather and cool rains are conditions unfavorable to their development.



FIG. 1.—The California devastating grasshopper.

breaks follow a succession of comparatively dry years. Grasshoppers usually deposit their eggs on knolls, ridges, or well-drained hillsides. In the Sacramento Valley of California grasshoppers also hatch in large numbers on grass lands which sometimes are flooded by a foot or more of water in early spring. A similar condition obtains in some of the valleys of the Sierra Nevada Mountains, where the meadows are flooded after the snows melt. Alternate freezing and thawing, or even severe drying after an early fall rain, appears to disturb many of the egg pods sufficiently to admit moisture and destroy the eggs. A heavy frost is fatal to many nymphs. Cloudy weather and cool rains are conditions unfavorable to their development.

SOME OF THE COMMON DESTRUCTIVE GRASSHOPPERS.

The California devastating grasshopper¹ (fig. 1) is yellowish brown in color, and has small dark spots on the wings. It measures about 1 inch in length. It breeds mostly on dry lands and dry alfalfa fields. The adults of this species are active in flight, and are very destructive to orchards, vineyards, alfalfa, gardens, and bean fields.

The differential grasshopper² (fig. 2) is a large species, measuring about 1½ inches in length. In color it varies from yellow to rich

¹ *Melanoplus devastator* Scudder.

² *Melanoplus differentialis* Thomas.

brown, with dark markings on the legs. The wings are without distinctive markings. Some of the nymphs are almost green. It is very destructive in alfalfa fields, where it breeds in abundance, and also attacks adjoining orchards, gardens, or cornfields. This species is clumsy in flight and never migrates far.

The lesser migratory grasshopper¹ (fig. 3) is a yellowish or light brown species averaging about 1 inch in length. It breeds on waste areas and alfalfa fields, and is especially destructive to alfalfa, melons, beans, and corn.

The pellucid grasshopper² (fig. 4) is ashy brown with dark spots on the wings. A light yellowish form is sometimes present. This species breeds abundantly on grass lands, and is destructive to mountain meadows, corn, oats, beans, orchards, and gardens. It is active in flight and frequently appears in swarms.

The margined grasshopper³ (fig. 5) is a small, dark-brown species, measuring slightly less than an inch in length, and

normally is almost wingless. It breeds in alfalfa fields and foothills and attacks orchards, bean fields, and gardens.

The enigma grasshopper⁴ (fig. 6) is a yellowish species about 1 inch in length. It has short wings and is awkward in flight. It breeds mostly on grass lands, and has proved very destructive to almond orchards, alfalfa, and bean fields.



FIG. 2.—The differential grasshopper.

¹ *Melanoplus atlantis* Riley.

² *Oamula pellucida* Scudder.

³ *Melanoplus marginatus* Scudder.

⁴ *Oedaleus enigma* Scudder.

The foul grasshopper¹ is large and grayish, measuring about 1½ inches in length, with dark wing markings. It breeds abundantly on dry hillsides and attacks almond orchards along the foothills.

The red-legged grasshopper² is a brownish species, measuring about three-fourths of an inch in length. It breeds on waste areas and attacks alfalfa, beans, and corn. It is most abundant in the higher mountain valleys.



FIG. 3.—The lesser migratory grasshopper.

COMMUNITY ACTION.

Grasshoppers frequently develop in great abundance on the uncultivated lands, where they can do comparatively little harm, and migrate into irrigated districts, where they feed upon valuable crops on intensively cultivated areas. The ranges, foothills, grassy meadows, and uncultivated alfalfa fields are favorite breeding places from which grasshoppers frequently migrate. Such migrations are

¹ *Dissosteira spurcata* Sauss.

² *Melanoplus femur-rubrum* DeGeer.

often so severe and sudden that communities must be organized and prepared to meet the attack in order to prevent destruction of their fields and orchards. Such work can best be accomplished by the farmers' organizations in the different localities.

The following outline is given as a helpful suggestion in organizing a community against the invasion by this pest: (1) A farmers' organization with energetic leaders; (2) the cooperation of county horticultural inspectors and farm advisers; (3) representation of the range and foothill landowners as well as those practicing intensive agriculture; (4) means of securing necessary funds for quick action; (5) a business man to locate and purchase supplies in large quantities; (6) the necessary legal advice for burning over waste areas and spreading poison on properties of nonresident and uninterested landowners; (7) reliable persons to supervise the preparation and spreading of the poison mixture; (8) definite days designated for the "grasshopper campaign," in order to cover the largest possible area at one time and thus prevent reinfestation of fields once cleaned up.

CONTROL METHODS.

The following control methods are based mostly upon the agricultural and climatic conditions prevailing over the area extending from southern Oregon through California, Nevada, and western Arizona. The methods advocated have been thoroughly tested over a period of five years and practised with excellent results on diversified farms, orchards, vineyards, and large ranches. The recurrence of serious losses to farm crops by grasshopper outbreaks can in most instances be prevented by diligent application, in due time, of the methods herein described.

There are many different methods by which grasshoppers may be fought. Some of these are: The use of the hopperdozer, destroy-



FIG. 4.—The pellucid grasshopper.

ing the eggs in the soil, the use of fire, driving the wingless species and nymphs into pits, and the use of poison in one of several attractive baits. These and other methods all have their use under certain particular conditions, and two or more of them can frequently be combined in a fight against this pest.

For general use the poisoned-bran mixture has given the most satisfactory results in grasshopper control, and this method is especially emphasized in the present discussion of the subject.



FIG. 5.—The margined grasshopper.

The following formula has proved most effective, and is recommended:

Paris green, or white arsenic.....	1 lb.
Molasses, cheap blackstrap	2 qts.
Lemons	$\frac{1}{2}$ doz.
Water	about 4 gals.
Wheat bran, or alfalfa meal.....	25 lbs.

THE POISONED-BRAN MIXTURE.

PREPARATION OF THE MIXTURE.

The poisoned-bran mixture has given most satisfactory results in grasshopper control. When prepared it consists of a wet bran mash with sufficient poison to kill this pest, and flavored with molasses and lemon to render it most attractive. A slight variation with regard to the proportion of water required in the mixture may be necessary under varying climatic conditions. It should never be so wet that the liquid drains out. The poisoned-bran mixture apparently is most attractive while moist and fragrant with the odor of lemon and molasses, at least under California conditions, although it is taken freely by grasshoppers after drying for a day or more in the hot fields.

This amount should be sufficient to cover about 5 acres. The cost of these materials averages from 30 cents to 50 cents per acre.

The following articles (fig. 7) are necessary, or at least convenient, for mixing the poison:

- Bucket for measuring water.
- Shovel, or hoe, to stir the bran.
- Tub in which to mix the liquids.
- Small platform or mixing box.
- Meat grinder to grind lemons.
- Small scales for weighing poison.

The molasses, Paris green, ground lemons, and water should be mixed in the tub and stirred thoroughly. Then slowly pour this solution over the bran in the mixing box and stir with a shovel until an even mixture is secured. It is sometimes preferable to mix the bran and Paris green dry, adding the water containing the molasses and lemon.

White arsenic may be used with good results as a substitute for Paris green, but does not mix so readily, and therefore requires much more prolonged and careful stirring to insure the best results. Alfalfa meal is a good substitute for bran, but does not spread as uniformly from a grain seeder as the coarse-flaked bran. Sour oranges and grapefruit may be used in place of the lemons.

WHEN TO POISON.

The spreading of poisoned bran should begin with the abundant appearance of small grasshoppers and before actual loss to the crops has occurred. Warm sunny days should be selected if possible, since the small nymphs feed very little when it is cool and cloudy. Hot and dry weather proves most satisfactory. The grasshopper eggs usually hatch later on cool, damp soils than on dry gravel ridges, and for this reason it is sometimes necessary to repeat the spreading of poison for the complete control of this pest. If the grasshoppers



FIG. 6.—The enigma grasshopper.

are found to spend the night under sod or clods and come out to feed in the morning, the best results are secured by spreading the poison early in the day before the grasshoppers begin moving about on the ground. On alfalfa fields, meadows, and dry-grass lands it usually is best to spread the poison in the afternoon of a hot day. Whenever the infestation is general the largest possible area should be covered in the shortest possible time to prevent reinfestation. Poisoning the grasshoppers late in the summer is of value in preventing eggs from being deposited in the soil.

SPREADING THE POISONED BRAN.

The poisoned bran mixture should be spread while it is wet, and within one day after it is prepared. It ferments rapidly in hot



FIG. 7.—Preparing the poisoned bran mixture.

weather if allowed to stand, and there is an increased danger of poisoning live stock if sacks of the prepared poison are kept around the yard. Along fence lines, narrow ditch banks, and rocky hill-sides the mixture is most conveniently spread by hand from a bucket. It should be spread as finely as possible, lumps being avoided. Over orchards, alfalfa fields, and ranges it can best be spread with an end gate grain seeder (fig. 8).¹ The poisoned bran mixture is thrown into the hopper in small quantities with a paddle or small shovel, using slightly less than a sackful of the mixture over an area of 5 or 6 acres. When properly spread it is so thin that the bran can hardly be seen on the ground.

¹ The type of seeder useful for this purpose has a horizontal spreading wheel which throws the bran mixture out with considerable force.

RESULTS TO BE EXPECTED.

Under the most favorable conditions large numbers of grasshoppers have been killed as early as eight hours after the poison was spread in the fields, but usually the maximum number of dead hoppers will be noticed two or three days later. These may be found under clods or weeds and in the crowns of alfalfa plants. The poisoned grasshoppers are eaten by other grasshoppers, beetles, and ants, in which the poison is again effective.

DANGER OF POISONING LIVE STOCK.

After the poison has been finely and properly spread over the fields at the rate of 25 pounds of dry wheat bran to 5 acres, there



FIG. 8.—The end-gate grain seeder in use for spreading grasshopper poison.

is no danger of poisoning live stock. The danger lies in preparing and keeping this attractive mixture around the farmyard where poultry and live stock are present and might eat quantities of it; also in spreading it by handfuls or lumps over the field. It is advisable to keep poultry penned up for a few days after spreading the poison; or to feed them well in the morning if they are to run at large where the poison is being spread, so that they will not pick up too many of the poisoned grasshoppers.

DESTROYING EGGS BY CULTIVATION.

Grasshoppers deposit their eggs in the soil, frequently at the bases of plants with bushy crowns. The abdomen is worked into

the soil to a depth of 1 or 2 inches (fig. 9). The eggs are deposited with a secretion which later dries and forms a waterproof protection for each egg mass. From 20 to 100 eggs may be deposited at one time. The egg pod or mass is completely sealed up before the abdomen is withdrawn from the ground.

Thoroughly cultivating and pulverizing the soil to a depth of 3 inches late in the fall will break many of these pods and expose the eggs to the action of the weather. Eggs thus exposed will mold with an abundance of moisture and will dry up if there is a lack of moisture. Alternate freezing and thawing of the exposed eggs aids greatly toward their destruction.

Spring cultivation, however, is of less value in destroying grasshopper eggs. Soil kept loose and pulverized throughout the sum-

mer is not selected by the grasshoppers as a place to deposit their eggs.

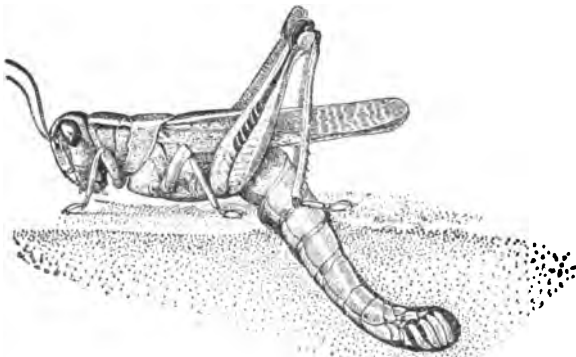


FIG. 9.—Grasshopper laying her eggs. (Webster.)

BURNING OVER DRY AREAS.

Fire has frequently been used with splendid success in connection with grasshopper control, and is practicable where the

vegetation is dry and dense enough to produce a hot flame. These conditions frequently obtain in the regions to which this discussion particularly applies. The danger of fire can not be too highly emphasized, and every possible precaution should be taken to safeguard buildings, ranches, forests, and orchard trees. Burning over waste areas and fence lines during daylight frequently proves unsatisfactory because the flames drive the grasshoppers from the dry grasses into adjoining fields and orchards. Very few grasshoppers will escape the flames if the burning is done at night. Their migration from the ranges into farming communities frequently can be checked by burning over an area from 20 to 40 rods wide between the cultivated fields and the open range country.

USE OF TURKEYS.

Large flocks of turkeys are sometimes secured to feed upon and reduce the numbers of grasshoppers. Turkeys are of value in utilizing grasshoppers in such a way as to turn them into human food,

and on outlying waste areas, where no expensive crops are in danger, this is a good practice. But grasshoppers abundantly infesting alfalfa fields, orchards, vineyards, or bean fields can seldom be satisfactorily controlled by this method. The turkeys feed for a short time and then rest. Their presence also interferes with other and more effective control measures.

CONTROL ON THE RANGES.

The earliest appearance of grasshoppers is usually on the gravel soils of the rolling range lands which are warmed by the first sunny spring days. Four or five species frequently appear as very small, wingless nymphs, hopping among the grasses. One species may be especially abundant in a certain locality and a different species most abundant just a few miles away. The nymphs feed upon the grasses and develop rapidly. Winged forms usually become abundant in May and June. By this time the grasses on the unirrigated areas and foothills of California usually mature and dry. It is at this time that the grasshoppers migrate to green fields and orchards in the irrigated districts. The most pronounced migrations from the ranges follow hot winds and rapid drying of range grasses. Every effort should then be made to control these pests. The poisoned bran mixture has been most effective, and may be used with good results at reasonable cost. Migration sometimes can be checked by burning over an area from 20 to 40 rods wide between the infested grass lands and the farming community. Sometimes the grasshoppers are especially abundant on certain sunny slopes, where they can be effectively poisoned. If the area of uncultivated country is too large to cover with poisoned bran, much can be accomplished by spreading the poison in strips with grain seeders, driving about 200 feet apart, and not attempting to cover the area completely.

It is sometimes possible to drive grasshoppers back from cultivated fields, and concentrate them for more effective poisoning, by herding sheep slowly back and forth, thus keeping the grasshoppers moving in the desired direction.

CONTROL IN ALFALFA FIELDS.

Alfalfa fields become infested from two principal sources. The early infestations usually come from waste areas and range lands when the migratory grasshoppers become active. This may be followed by the abundant hatching of one or two additional species on the cool soils of irrigated fields. *Melanoplus differentialis* Thomas, a large and most destructive grasshopper, greatly favors alfalfa as food, and deposits its eggs on the ridges, ditch banks, and fence lines. *M. marginatus* Scudder, a small, short-winged form, is also a de-

structive grasshopper, especially in California, seldom migrating far from alfalfa fields, where it breeds in abundance.

The poisoned bran mixture applied early in the season along edges of the field, and later over the entire field, has given excellent results.

Lightly infested fields may be cut so as to leave strips, or lands, of standing alfalfa to attract and concentrate the grasshoppers. They can then be poisoned at a comparatively small cost. The grasshoppers usually roost on the alfalfa stems during warm nights, feed early, and descend to the ground as the heat of the sun becomes intense. They feed ravenously in the late afternoon following a hot day. The best results therefore are secured by spreading the poisoned bran mixture on fields with standing alfalfa in the afternoon of hot, dry days.

CONTROL IN ORCHARDS AND VINEYARDS.

Orchards (fig. 10) and vineyards suffering most severely from grasshopper attacks are those bordering on or within the radius of grasshopper migration from infested alfalfa fields, foothills, or waste areas. Grasshoppers do not deposit their eggs in the loose soil of carefully cultivated orchards. Uncultivated fence lines or roadsides may, however, be



FIG. 10.—Grasshopper injury to fruit tree.

a source of infestation. Every effort should be made to poison the grasshoppers before they enter the trees or vines. If they are already present in the orchard, the poison should be spread over the ground and the grasshoppers shaken from the branches and kept moving so

that they will find the poison. On the cultivated soils the grasshoppers frequently descend in the evening and spend the night under the warm clouds. Best results are then secured by spreading the poison in the morning, since the grasshoppers again make their appearance with the first rays of the morning sun and will take the poison bran before entering the trees. The poison mixture never should be placed in small piles against the trees, since burning of the bark may result. Covering small trees with cheesecloth or burlap frequently is practised, but is useful only for temporary protection (fig. 11). Grasshoppers eat through the lighter material and girdle the tree where the cloth is tied, unless it is extended to the ground.



FIG. 11.—Part of an almond orchard. Small trees covered with cloth. The grasshoppers soon ate through the cloth and girdled many trees where the cloth was tied.

CONTROL IN MOUNTAIN MEADOWS.


Mountain meadows frequently become infested from the grassy slopes of surrounding hills and from low ridges, where the grasshoppers collect in the fall to deposit their eggs. The small grasshoppers appear in early summer and destroy the valuable meadow grasses. The poisoned bran mixture has given splendid results in destroying grasshoppers under these conditions, and in some sections has saved stockmen thousands of dollars' worth of fodder. The poisoning should begin when the nymphs appear in considerable numbers, and should be continued until late in the fall, even after the crops have been removed from the fields, if necessary. This later poisoning is to prevent the laying of eggs in the soil.

CONTROL IN CULTIVATED FIELDS.

Corn, grain, and bean fields frequently suffer severe injuries from grasshopper attacks. Such infestations usually come from uncultivated, waste areas and alfalfa fields, to which the grasshoppers frequently return for the night. The poisoned bran mixture should be spread over such adjoining waste areas, as well as on the fields where the crops are injured. On the cultivated fields it is well to spread the poison during the morning hours, when the grasshoppers are coming in.



FARMERS' BULLETIN 1141
United States Department of Agriculture



RICE GROWING in California



RICE produces its largest yields on clay soils that are not too deficient in organic matter. The land selected for rice culture should lie in level tracts that can be cheaply drained.

The crop requires an abundant and always available supply of fresh water. To obtain good yields of high-grade rice the land must be submerged continuously for several months, and ample drainage facilities also must be provided.

The surface soil of the seed bed should be loose and finely pulverized to a depth of at least 2 inches.

The field levees should be low, broad, and permanent and should be constructed on contour lines at distances which will hold the water at an average depth of 6 inches.

The harvested rice should be put into strongly built shocks well capped to protect the grain from the rain as well as the sun. The rice should remain in the shock for at least one week before thrashing is done.

The short-grain rices are well adapted to the great central valley of California. The long-grain and medium-grain rices do not develop normally in California. They mature later than the short-grain varieties and produce comparatively low yields of grain of poor milling quality.

The worst weed pest in California rice fields is barnyard grass. Land that is badly infested with this grass should be cleaned by fallowing and frequent cultivations before it is sown to rice.

This bulletin is a revision of Farmers' Bulletin 688, The Culture of Rice in California, issued September 18, 1914.

Contribution from the Bureau of Plant Industry

WM. A. TAYLOR, Chief

Washington, D. C.

September, 1920

RICE GROWING IN CALIFORNIA.

CHARLES E. CHAMBLISS, *Agronomist in Charge of Rice Investigations, Office of Cereal Investigations.*

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HISTORY OF THE EXPERIMENTS.

THE OFFICE OF CEREAL INVESTIGATIONS of the Department of Agriculture began varietal experiments with rice in the vicinity of Biggs, Calif., in the spring of 1909. The experiments were conducted in that locality during the three succeeding years, and during the same period similar experiments were made with a smaller number of varieties at several places in the Sacramento and San Joaquin Valleys. These experimental sowings, which were conducted in cooperation with ranchers, furnished some valuable data on the commercial possibilities of rice culture in California and laid the foundation of a new industry for the State.

In order that these studies might be enlarged and conducted under more favorable conditions, the Biggs Rice Field Station (fig. 1) was established in 1912 with the assistance of ranchers, who organized the Sacramento Valley Grain Association for the purpose of co-operating with the United States Department of Agriculture. The station farm, consisting of 57 acres, is located 4 miles northwest of Biggs and is irrigated by gravity from the Feather River through a canal system operated by a private company. Its soil is black adobe, which is representative of a considerable acreage of land in the Sacramento Valley, on which rice is very productive.

The first commercial crop of rice in California was grown in 1912 on adobe soil in the Sacramento Valley near Biggs. The profits from

this crop of 1,400 acres were large. The wide publicity that was given to the possibilities of rice culture on black-adobe soil resulted in the sowing of more than 6,000 acres in 1913. The greater part of this acreage was in Butte County, though there were several small sowings in the San Joaquin Valley. The average yield of 3,200 pounds of grain per acre which was produced by the 1913 crop gave so great an impetus to the industry that in 1914 the area sown to rice was increased to 15,000 acres. Since that time rice production has increased rapidly, as is shown in Table I. In 1919 rice was grown on 142,000 acres, and the resulting crop was valued at more than \$21,000,000.



FIG. 1.—Buildings at the Biggs Rice Field Station, Biggs, Calif.

TABLE I.—Acreage, production, and farm value of rice in California from 1912 to 1919, inclusive.

Year.	Acreage.	Yield (bushels).		Farm value, Dec. 1.	Year.	Acreage.	Yield (bushels).		Farm value, Dec. 1.
		Average per acre.	Total.				Average per acre.	Total.	
1912.....	1,400	50.0	70,000	\$64,000	1916.....	53,300	59.0	3,263,000	\$2,545,000
1913.....	6,100	48.0	293,000	233,000	1917.....	80,000	70.0	5,600,000	9,800,000
1914.....	15,000	53.3	800,000	800,000	1918.....	106,220	66.0	7,011,000	13,321,000
1915.....	34,000	66.7	2,268,000	2,041,000	1919.....	142,000	55.5	7,881,000	21,042,000

SECTIONS OF CALIFORNIA IN WHICH RICE IS GROWN.

The rice acreage of California in 1919 was distributed by counties as follows: Colusa, 39,050; Glenn, 34,500; Butte, 34,150; Sutter, 8,700; Yolo, 8,400; Yuba, 6,200; Solano, 3,000; Stanislaus, 2,500; Kern, 1,500; Merced, 1,500; Fresno, 1,000; Placer, 800; Shasta, 700. The distribution of the acreage is shown in figure 2.

The production of rice at present is confined to the Sacramento and San Joaquin Valleys, the northern and southern sections of a continuous valley more than 400 miles in length and from 20 to 60 miles in width that occupies the north-central portion of the State. To the east of this great valley lie the foothills and forested slopes of the Sierra Nevada Mountains. From this region of heavy precipitation flow many perennial streams which may be used to supply

water for a very large acreage of rice. The streams that flow into the valley from the Coast Range do not supply water in dependable quantities for rice production.

CLIMATE.

The prevailing climatic conditions of this great central valley of California are moderate rainfall, hot, dry summers, mild winters, low humidity, and light wind movement. The region is semiarid.

Rains seldom fall during the summer months, most of them occurring from October to May. These limits, however, are subject to considerable variation.

The average annual rainfall ranges from 24 inches at Red Bluff, at the northern end of the valley, to 5 inches at Bakersfield, at the south-

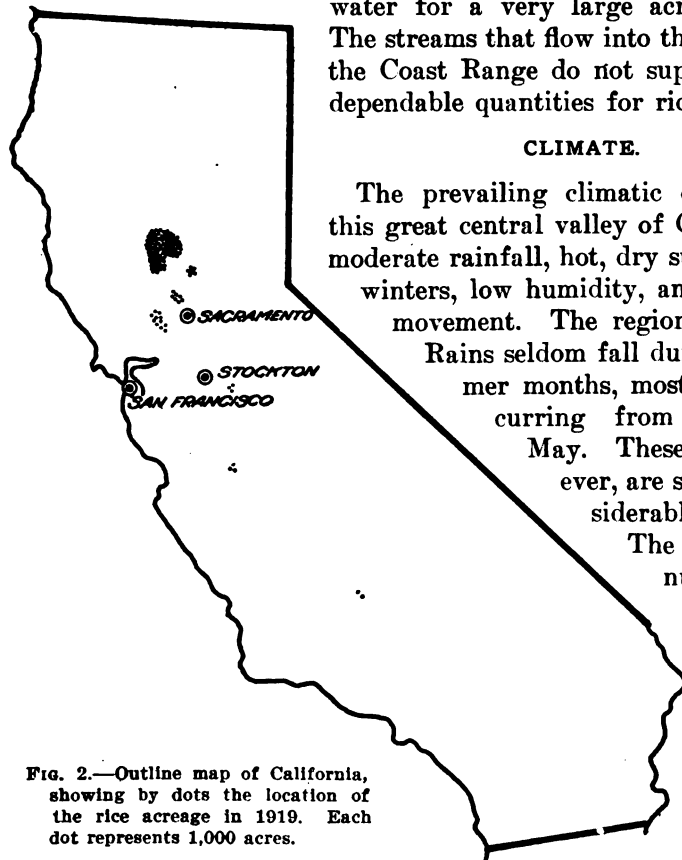


FIG. 2.—Outline map of California, showing by dots the location of the rice acreage in 1919. Each dot represents 1,000 acres.

ern end. The mean annual temperature ranges from 60° to 65° F. The highest temperatures occur in the months of July and August, ranging from 105° to 115° F. During the hot months there is often a daily variation of 40° degrees, resulting in rather cool nights. In the winter, minimum temperatures of less than 25° F. are seldom recorded. The usual minimum is about 28° F. Frosts occur frequently in December and January.

In the Sacramento Valley the prevailing wind during the spring and autumn months is often brisk. Hot, dry winds from the north sometimes occur during the summer months. In their extreme form

they are called "northers." When they continue for several days, they often do considerable damage to rice, especially if they occur while the crop is in flower.

SOILS.

The larger part of the rice crop in California is grown on black-adobe soil. This soil contains approximately 50 per cent of clay. In structure it is very close and compact, and it is exceedingly tenacious and puttylike when wet. During the dry season it breaks at the surface into blocks separated by deep cracks. After long exposure to the air these blocks divide and subdivide by smaller cracks until the surface of the soil may become a loose, shallow mass of small pieces the size of peas. The subsoil, which lies at a depth of approximately 3 feet, is gray in color and is rather impervious to water. There are approximately 200,000 acres of this soil in the Sacramento Valley that may be used for the growing of rice.

The Sacramento silt loam, a light-brown soil which occupies a large area in the eastern part of Colusa County, seems well adapted to rice. It is of alluvial origin and varies in depth from 18 inches to 6 feet. In texture and structure it is variable, but as a rule it can be easily cultivated. The heavier type of this soil has a tendency to form hard clods, which are somewhat difficult to reduce.

Good yields of rice are obtained on the Willows clay. This is an indefinite type of soil that occurs in large areas on the nearly level plain south and southeast of Willows. It has a depth of approximately 6 feet. This soil is a reddish and yellowish brown clay that is compact, tenacious, and impervious. It puddles badly when wet and bakes on exposure to the sun. On account of its texture this soil is not easy to cultivate. It contains from 0.04 to 1.2 per cent of alkali.

Rice may be grown successfully on the Alamo clay-loam adobe. This soil varies in color from dark gray to black and in depth from 1 to 5 feet. It is both sedimentary and alluvial in formation and lies upon a red hardpan. It occupies an area that is subject to overflow during the rainy season.

Other types of clay soil in these two valleys are used for rice with success. Fair yields have been obtained on some soils where the surface gave indications of a high alkali content. These salts may be present in relatively small quantity concentrated near the immediate surface. They can be easily removed by the irrigation water, which indicates that with thorough drainage and an ample supply of water for irrigation rice may be profitably used to reclaim these alkali lands. Rice is apparently more resistant than other cereals to alkali salts.

GENERAL REQUIREMENTS OF THE CROP.

Irrigation is an important feature in the culture of rice. Water must be applied continuously and at a uniform depth for many days. To meet these requirements the land that is selected for this crop should be level and underlain by a subsoil that is impervious to water. A level tract is better suited to rice than a slightly rolling one, because it is less expensive to prepare and to maintain on account of requiring fewer levees. The impervious stratum of soil should lie near the surface, for a deep soil requires more water and more time for its submergence than a shallow one.

The importance of good drainage can not be too strongly emphasized. Without it a rice field can not be properly drained for harvest. Delay in draining a field at this time may cause a heavy loss in yield. Drainage also is necessary in order to prevent water-logging, a condition which unquestionably affects the yield. Clay soils, when easily drained and not too deficient in organic matter, seem well suited to the production of rice. Loamy and even sandy soils produce good crops of rice under ideal conditions of irrigation and drainage.

SOURCES OF IRRIGATION WATER.

The water that is used for the irrigation of rice in the Sacramento Valley is obtained mainly from the Sacramento and Feather Rivers. It is taken out of these streams by gravity or lifted by large pumps for distribution by canals, which are operated by private companies that sell the water on an acre-foot basis or at an annual charge per acre. In the San Joaquin Valley the greater part of the rice acreage is watered from deep wells. They may be used to supplement the gravity supply, though the wells often are the only source of water.

If the water supply is to be developed from wells, the digging of these should precede the seeding of the crop. When this has not been done heavy losses have resulted. The acreage to be watered from a well should never overtax the supply. Until more is known about the underground waters of these two valleys, wells should not be depended upon as the only source of water for rice except in the artesian districts.

The successful growth of this crop depends upon the availability of water at the time of seeding. While it will not always be necessary to apply water for the germination of the seed, it is never safe in California to sow the crop without having a good supply of available water.

PREPARING FIELDS FOR IRRIGATION.

Level land with a gentle slope is well suited to the irrigation of rice. With such surface features a field can be irrigated economically and drained satisfactorily if the natural outlets are not too small and are not overtaxed. A rice field must be inclosed by strong levees, in order to hold the water that must be put upon it. As it is also important to maintain a rather uniform depth of water in irrigating rice, the field must be divided into as many subfields, or "cuts," as are necessary to obtain this condition.

A competent civil engineer should be employed to locate the levees, especially those that separate the subfields. These levees should be permanent and should be constructed on contour lines at distances which will hold the water at an average depth of 6 inches. They should be at least 10 feet wide at the base and built up with sloping sides to a height just sufficient to prevent the water from overflowing into the subfields below. All kinds of farm machinery easily pass over levees of this character without damaging them. This simplifies field operations, for such levees make possible the cultivation of an entire field as a unit instead of the separate cultivation of "cuts," which is necessary where high, narrow levees are used. These broad levees are advantageously seeded to rice in sections where there is considerable rainfall during the growing season. In the great central valley of California, which is semiarid, the conditions on the levees are not suited for good plant growth, but they should be sown to rice in order to control weeds.

Firm and compact levees are necessary to reduce seepage. They should be constructed or rebuilt during the winter. When constructed at this time they are more serviceable than when made just before water is applied. It is better to build new levees at least one-third higher than the stated requirement, thus allowing for settling and washing.

The water is admitted to subfields through openings in the levees. These openings should be controlled by wooden gates and not made with a shovel each time water is needed. The gates should consist of a floor and end pieces to hold a sliding shutter in a vertical position across the opening. The flow of water may be regulated by the shutter, which consists of narrow pieces of wood that may be increased in number or removed as the water is raised or lowered.

VARIETIES.

The leading rice varieties of California are the short-grain rices, the Wataribune and two unnamed varieties known as C, I. No. 1564

and C. I. No. 1600. They are very hardy and produce large yields, but require a long growing season.

Early-maturing rices are very desirable for the Sacramento Valley. No variety maturing within five months at the Biggs Rice Field Station possesses quality and yielding capacity that would make it valuable for commercial purposes.

The long-grain and medium-grain rices, represented, respectively, by the Honduras and Blue Rose varieties, which are very productive in Louisiana, Texas, and Arkansas, have not been successfully grown experimentally or commercially in California. They do not develop normally (fig. 3), mature later than the short-grain varieties, and produce comparatively low yields of grain of poor milling quality.

The Wataribune variety (fig. 4) has short, broad seeds which average in length four and in width seven to the inch. The hull is light yellow in color and bears a light-yellow awn, at the

base of which are tufts of short white hairs. Many of the awns drop before the crop is harvested and those that remain are usually broken off in thrashing and in handling the sacks, so that this variety often goes to the mill with very few, if any, awns attached.

The seed of the Colusa variety (C. I. No. 1600) has a light-yellow hull thinly covered with short white hairs and is awnless (fig. 5). This rice matures earlier than the Wataribune variety. On rich



FIG. 3.—Two heads (botanically called panicles) of the Honduras variety, a long-grain rice. These heads have not emerged completely from the leaf sheath. This is characteristic of all long-grain and medium-grain rices that have been tested in California. Plants that mature in this manner do not produce large yields of grain of good milling quality.

new land it produces large yields, but is less productive on old rice land because it tillers less under these conditions.

The hull of the seed of the Butte variety¹ (C. I. No. 1564) is light yellow in color (fig. 6). It is thinly covered with short white hairs and bears a light-brown awn, which remains tightly attached. This variety grows well on land that has been previously cropped to rice, but it does not tiller as heavily under these conditions as the Wataribune and for this reason should be seeded at a rate of 25 per cent greater. The grain does not shatter readily, which is an advantage at harvest if for any reason cutting is delayed, but somewhat of a disadvantage in thrashing, especially if the straw is not thoroughly dry.



FIG. 4.—Seed rice of the Wataribune variety. (Natural size.)

Each of these three varieties, when seeded early in April on well-prepared land, produces an average yield of over 4,000 pounds per acre. The last two varieties mature approximately a week earlier than the Wataribune rice, and the grain which they produce is similar to it in size and quality.

PREPARATION OF THE SEED BED.

When not contrary to good farm management and when the nature of the soil will permit, plowing should be done in the late autumn. There should be good drainage, so that the winter rains will wash

¹ These varieties, which have been quite widely distributed under Cereal Investigations Nos. 1600 and 1564, respectively, are now named Colusa and Butte, the names of two of the leading rice-producing counties in the Sacramento Valley.

out any alkali which may have accumulated in the surface soil. Deep plowing should be practiced. The action of the rain during this period will reduce the clods, which will lessen the amount of disking and harrowing necessary for preparing a good seed bed the following spring.

If plowing is delayed until spring, the land should not be left rough, but should be disked and harrowed at once and not allowed to dry before sowing.

The vigorous growth of the young plants, as well as high germination, is dependent on a seed bed with a surface soil that is loose and finely pulverized to a depth of at least 2 inches.



FIG. 5.—Seed rice of the Colusa variety (C. I. No. 1600). (Natural size.)

PREPARATION OF THE SEED.

All seed rice should be graded and cleaned before it is sown. A fanning mill may be used for this purpose. Ungraded seed is likely to produce a poor stand, and the use of uncleaned seed is one way by which weeds are introduced or increased in a field. Although rice without hulls may germinate under favorable conditions, seed rice containing it is inferior for seeding purposes. It is more easily damaged by unfavorable weather following seeding than the seed with the inclosing husk or hull. The use of seed containing rice without hulls results always in a thin stand or a stand with many weak plants.

Seed rice should always be tested for germination, as it may have been exposed to conditions that have affected its germinating power.

For a germination test several lots of 100 seeds each should be taken from a sample of the seed to be sown. Each lot should be placed separately between blotting papers or Canton flannel and kept moist at a living-room temperature (70° F.) for at least a week. The number of seeds that have strong sprouts should then be counted. Seed that shows low vitality should not be sown, but, if it must be used, the rate of seeding should be higher than that commonly recommended for the variety.

METHOD OF SEEDING.

In sowing rice the seed should be distributed evenly and covered uniformly. These results are more easily obtained by drilling the

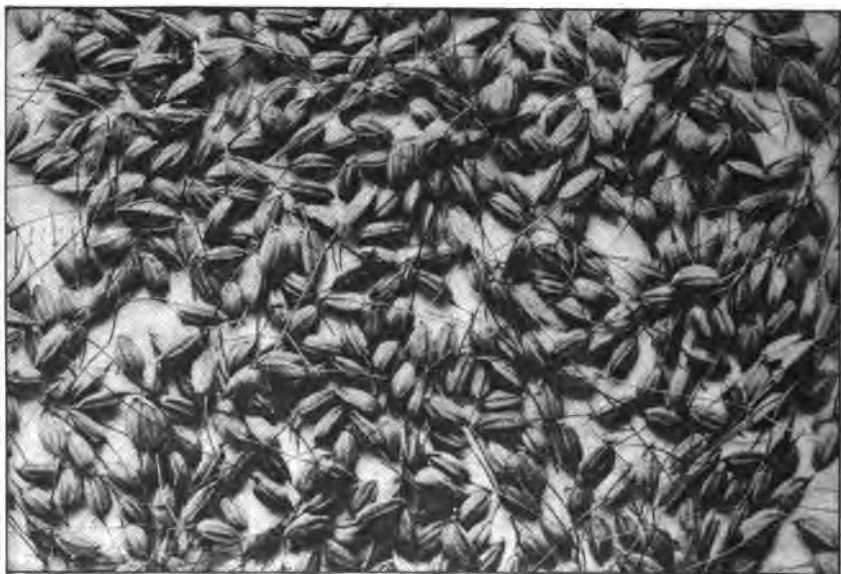


FIG. 6.—Seed rice of the Butte variety (C. I. No. 1564). (Natural size.)

seed than by broadcasting it. When drilled, less seed is required, and as a rule a more uniform stand is obtained. Any one of the ordinary forms of drill may be used if the seed bed is in good tilth.

TIME OF SEEDING.

In California approximately six months are required to mature a crop of rice, and for that reason early seeding should be practiced. The crop should be sown early enough to be harvested before the autumn rains begin. If seeded at an early date the crop will flower under normal conditions during the period of high temperatures, with a resulting increase in yield and improvement in quality. The risk of losses from wet weather increases as the harvest period comes later. In a date-of-seeding experiment at the Biggs Rice Field Sta-

tion, in which rice was sown every 15 days from April 1 to May 15, inclusive, the early seeding has invariably produced the largest yields. The yields from each successive sowing were from 400 to 500 pounds per acre less than from the preceding one. The same proportional decrease in yield was noted on the commercial fields near Biggs. April 1 is recommended as the approximate date for sowing rice in California. It is not safe to sow rice in that State after May 1.

RATE OF SEEDING.

The quantity of seed that should be sown varies with the variety of rice, the vitality of the seed, the fertility of the soil, the character of the seed bed, and the method of seeding. Under ordinary conditions, on black-adobe soil, 90 pounds of seed to the acre are sufficient for the Wataribune variety.

Thin seeding may induce excessive tillering, which invariably results in irregular ripening and low yields. On a good seed bed less seed will be required than will be necessary to get an average stand on a poorly prepared one. If weedy land is used, the rate of seeding should be greatly increased. It is always necessary to use more seed in broadcasting than in drilling.

DEPTH OF SEEDING.

Rice should be sown under ordinary conditions at a depth not exceeding 2 inches, but a greater depth may be required on a cloddy field in order to cover the seed well. With proper moisture conditions shallower seeding is desirable on a well-prepared seed bed. When irrigation is necessary to obtain germination, the seeding should not be too shallow or the water may float and scatter the seed.

TIME TO APPLY IRRIGATION WATER.

On typical adobe soil, and probably on all of the clay soils on which rice may be grown, it may be necessary to apply water to germinate the seed. A seed bed on these soils loses its moisture very quickly. Under normal weather conditions a good seed bed on soils of lighter texture may not require the application of water for germination. Such soils, if well drained, permit very early seeding, which is always an advantage in California.

Great care should be taken in irrigating to cause germination. Soil and atmospheric temperatures are usually low at this season of the year, and if water is left on the land too long the seed is likely to rot. Before the plants come up, water should not be allowed to remain on the land longer than 24 to 48 hours after each irrigation. After seeding, the soil should never be allowed to become dry. This

will require frequent irrigation, and a supply of water should always be available and abundant enough to meet the requirements.

According to experiments at the Biggs Rice Field Station, the subfields should be submerged about 30 days after the plants have emerged. The depth of water should be increased slowly until the maximum depth of 6 inches is obtained. By this time the plants should have reached a height of at least 18 inches. Throughout the growing season this depth is maintained, fresh water being applied when needed to supply losses from seepage, evaporation, and transpiration.

Paying crops of rice can not be produced without submerging the land continuously for a period of several months. The growing of rice on soil that is merely kept moist and not submerged should not be considered.

The amount of water required to make a good crop of rice depends largely upon how well the outside levees have been constructed and what quantity of water is allowed to flow through the field. To conserve water, the levees should be as near seepage proof as possible. Poorly constructed outside levees are responsible for the loss of much water.

The levees that inclose the field should be firm and compact. If they are next to a field that is not under irrigation, they should be very broad. Seepage is greater through levees that are constructed of black adobe than through levees that are made of other types of clay.

A further loss of water often results from allowing too much to flow through the fields, in an effort to keep the water fresh. After a field has been submerged no more water should be admitted than is necessary to retain the required depth. This will be rather small if no loss occurs through seepage. The overflow of water should be no more than a mere film. From many fields it is often several inches. This is an extravagant use of water and should not be practiced.

Too much attention can not be given to levees and to the delivery and discharge of water. Payment for water should be based upon the volume delivered. Upon this basis it would be more economically used than can reasonably be expected when sold on a flat charge per acre.

Under the climatic conditions of California about 5 acre-feet of irrigation water are required to produce a good crop of rice.

DRAINAGE.

The irrigation water should be removed promptly from the field when the crop is ready to be harvested. To do this effectively, ample provision should be made for drainage. This will require a number of ditches of sufficient depth and width to remove the surface water

and to drain the soil thoroughly. These ditches must be kept free from all kinds of obstruction, especially from weeds, which grow luxuriantly in them, or their capacity will soon become greatly reduced.

The number and the location of these ditches depend on the surface features of the land under cultivation. The surface water should be carried away quickly. This can be done by connecting the field outlets with watercourses or artificial channels of sufficient capacity. The latter is an engineering problem requiring community cooperation and can be readily solved in many localities by the creation of drainage districts.

On fields that drain slowly there is always delay in harvesting the crop, which invariably results in the loss of grain from shattering. Lack of drainage or poor drainage facilities will also increase the cost of production through the additional time and labor required to cut and move the crop from a boggy field. During the winter all drainage outlets should be kept open, so that surplus water will not remain on the land. This attention will prevent water-logging and the accumulation of harmful alkali salts in the surface soil and will also aid in the aeration of the soil. The importance of having control of these conditions is strongly emphasized, for without good drainage maximum yields can not be obtained.

HARVESTING THE CROP.

A twine binder should be used in cutting the crop. Rice is ready to harvest when the kernels on the lower part of the head (botanically called the panicle) are in the hard-dough stage. This stage of maturity is indicated by the position of the heads, the tips of which are then well turned down. If cut earlier, a large percentage of the kernels will be imperfectly filled. If cut later, the loss from shattering is likely to be heavy, for rice shatters badly when left standing until fully ripe. The harvesting of rice is shown in figure 7.

SHOCKING.

The milling quality of rice is greatly improved by prompt and careful shocking. As soon as the grain is cut the sheaves should be put in round shocks, which should be strongly built to withstand wind. The protection from the sun which the grain gets within the shock reduces the percentage of cracked kernels and consequently increases the value of the rough rice. While the harvested grain is likely to be damaged in California more from exposure to the sun than from dampness caused by rains, the losses from the latter cause may be heavy, making it important to cap the shocks for protection against rain as well as sun.

In building a shock the first two bundles should have the butts firmly set into the stubble sufficiently far apart to be well braced when the heads are brought together. Place around these 8 to 10 bundles in such a manner as to form a round shock, making provision at the same time for free circulation of air. Select a large bundle to serve as a cap. Slip its band down to the heads and put it in an upright position with the heads down and in contact with the heads of the bundles forming the shock. When it is in this position open the bundle from the center by bending the straw at the band. Pull down the straw and spread it evenly to make a covering for the heads of the cap bundle and the underlying bundles.

When the straw is wet or not entirely ripe, it is probably safer to build a smaller shock. A field of shocked rice is shown in figure 8.



FIG. 7.—Cutting rice with a twine binder. Before harvest the irrigation water is drained from the field.

THRASHING.

Rice should not be thrashed until the kernel is hard and the straw thoroughly dry. This requires at least one week in the shock. If the weather is rainy this period may be considerably prolonged. The damage to the grain in a well-constructed shock exposed to rains is negligible compared to the loss that may occur when thrashing is done too soon. The grain should not be thrashed too early in the day, even though it has been cured thoroughly in the sun. If thrashing is attempted while the straw is damp with dew the separation is likely to be poor, with a resulting loss of grain. There is danger, also, of further loss by heating if the grain is sacked and stored while damp. When thrashing is done under contract or where more than one variety is grown on a farm, special attention should be given to

the cleaning of the separator. This is necessary in order to keep varieties as pure as possible and to prevent the introduction of weeds from neighboring farms. Rough rice is greatly improved in grade by careful thrashing. Too much attention can not be given to the adjustment of the concaves to prevent hulling and cracking. (Fig. 9.)

WEEDS.

Under the general term of "weed" may be included those plants that interfere with the full development and marketing of any crop. The plants that normally inhabit wet places find in a rice field ideal conditions for rapid and luxuriant growth, and if not eradicated when they first appear may cause heavy losses. Because of abundant seed production and their general hardiness they are not easily controlled. Their presence in a field adds to the cost of production, reduces the yield, and produces an inferior grade of



FIG. 8.—A field of shocked rice in the Sacramento Valley.

grain. Rice containing weed seeds always sells for a lower price than clean rice.

The eradication of weeds is expensive, and it is therefore important to use every method to prevent their introduction. Most weeds are probably introduced into fields by sowing seed rice that has not been thoroughly cleaned. The irrigation water furnishes another source of infestation, being supplied from the weed growth in ditches and on ditch and canal levees. The community thrashing outfit also acts as a weed distributor.

The danger from these sources can be greatly minimized by the exercise of care, cleanliness, and good judgment. Weeding by hand should be resorted to as soon as weeds appear in a field, unless their number is so great that the cost makes it prohibitive. In the latter case the land should be fallowed and occasionally irrigated to germinate the weed seed. No weed should be allowed to mature its seed. This applies to weeds on roads and levees as well as to those

in the field. The former can be handled easily and cheaply by the use of mowing machines and scythes. The seeding of field levees to rice will reduce the area for weed growth.

BARNYARD GRASS.

Barnyard grass,¹ which is locally known as water grass, is the worst weed to be found in the rice fields of California. It is a coarse, erect, or spreading annual, varying in height from 12 to 48 inches. It is widely distributed in all cultivated regions and grows luxuriantly in fields that are continuously irrigated. This weed produces a large number of seeds. On a single plant there may be as many as 40,000 seeds. It is therefore not safe to allow a single plant to go to seed in a rice field, for with such seeding habits it would soon populate the field. During the last five years this grass has taken complete possession of several thousand acres of rice land



FIG. 9.—Thrashing rice in the Sacramento Valley.

in the Sacramento Valley and is now present in alarming quantities on a considerable acreage, which will soon be rendered unprofitable for rice growing unless active steps are taken for its complete eradication or control. A commercial sample of rice containing many seeds of barnyard grass is shown in figure 10.

This weed has probably been more widely distributed through the use of seed rice containing its seed than by any other means. Water from irrigation ditches upon the banks of which it has been allowed to grow contributes its quota of seed. The seed of this grass also is carried from one field to another by the floods which sometimes occur during the winter.

Seed rice containing the seed of barnyard grass should not be used. As soon as this grass appears in a field it should be removed by hand before it goes to seed. Its seed usually germinates with the rice, and in about two weeks after coming up it shows a more vigorous growth and a lighter green color than the rice plants. Rice requires approxi-

¹ *Echinochloa crus-galli* (L.) Beauv.

mately six months from seeding to harvesting in California, while barnyard grass matures its seed in from two to three months. It is possible, therefore, for this pest to produce two crops of seed before rice is harvested. This shows the importance of preventing the growth of barnyard grass in rice fields.

The only satisfactory method known at present for the eradication of this weed is to remove it from the field by hand. On account of their large root systems it is not practicable to pull up the plants. They should never be cut off at the surface of the ground, as is often done, for a new growth will develop and produce seed in about 40 days. The plants should be cut below the crown, which is usually



FIG. 10.—A commercial sample of seed rice of the Wataribune variety, containing many hulled grains and the seeds of barnyard grass. (Natural size.)

covered with 2 inches of soil. Plants which have been cut at the surface have been known to produce seed as many as four or five times during a season. As soon as they have been cut the plants should be removed from the field, for they will continue to grow if they are allowed to remain in moist or wet places.

It has been found practicable and advisable to cut this grass from fields even when the growth is very heavy. The cost of eradication will depend largely on the quantity in the field and on the class and cost of the labor employed. If this weed is allowed to seed in any quantity during the first year, it is almost impossible to eradicate it during the second year.

At present summer fallowing seems to be the best method to obtain the complete eradication of this weed. The conditions should first

be made favorable for the germination of the seeds that are in the soil. After germination the plants should not be allowed to produce seed. This can be done effectively by frequent shallow cultivation after the seed germinates. Irrigation probably will be necessary to assure germination.

In eight years this weed has become a menace to the rice crop of the Sacramento Valley. For the control or the eradication of this grass community, county, or State action is imperative if the rice industry of California is to reach its maximum development and permanency. Such agencies probably will never become effective until the greater part of the land cropped to rice is owned by the producers. Without such ownership the creation of a sentiment in favor of control by law is very remote. Any measure that may be employed now must carry with it full police powers to be effective.

RED RICE.

In the Southern States the worst weed of the rice fields is red rice. This weed has been introduced into California through the purchase of seed rice from the South. It is well distributed throughout the rice-producing countries of the world. Foreign seed may contain as much red rice as domestic seed, so there is also danger from this source. The seed coat of the kernel of this rice is red, which distinguishes it readily from the white rices. It is introduced only through the use of seed containing red rice. In discussing seed rice from the standpoint of red rice only, the importance of pure seed can not be overestimated. After heading, red rice can be readily distinguished from our commercial varieties by its loose, open, slightly drooping head with comparatively few grains on the branches.

A slight infestation of a small acreage may be easily controlled during the first year by pulling up the individual plants and removing them from the field. If this is not done, the quantity of red rice may greatly increase during the second year, for the seed of this rice shatters very badly. Some of it may be harvested and thrashed with the main crop, but the quantity will be proportionately small, though large enough to affect the grade. The presence of red rice always lowers the value of the crop.

WILD OATS.

The wild oat¹ is not a troublesome weed in the rice field, though it often makes a vigorous growth in fields where the stand is thin. It is usually brought under control when the first continuous irrigation water is applied.

¹ *Avena fatua* L.

CANARY GRASS.

Canary grass,² which thrives in wet soil, has caused loss in some fields. It germinates with the rice and, as it grows much faster, it may seriously affect the early growth of the crop if it is very abundant. While canary grass may never become a troublesome weed, it should not be allowed to establish itself in a rice field. It should be removed by hand when it first appears.

DISEASES AND INSECTS.

In the rice-growing sections of the Southern States the rice plant is subject to attack by four diseases and several species of injurious insects. None of these, or of any other species of fungi or insects, has been found in or reported to affect the rice crop of California.

RICE PRODUCTS.

Rice leaves the thrasher with the hull or husk attached. It is called rough rice and in this condition is sold to the miller. In the mills it is prepared for the market. After the removal of the hull and seed coat, or skin, the kernels are polished. The polishing improves the commercial value of the rice, but decreases its food value.

After the rough rice has been cleaned in order to remove all kinds of trash, it is conveyed to the milling stones, between which the hulls are removed. From these stones it passes over horizontal screens, where the hulls and the whole and broken kernels are mechanically separated. The unbroken kernels are now conveyed to a set of machines known as hullers, in which the outer skin and much of the gluten layer of the grain, together with the germ, are removed by friction. After leaving the hullers the rice is screened and fanned, to free it from the bran. It is again subjected to another scouring in a second set of hullers or in a pearling cone. It is now ready to be polished, a process which gives the kernels the pearly luster that is demanded by the general trade. In the polishing process more of the gluten layer and many layers of starch cells are rubbed off. This product is called rice polish. After the polishing the rice is screened. If it is to be coated with glucose and talc, as is generally done, it is conveyed to a revolving cylinder where the coating material is applied. The different grades of cleaned or milled rice are afterwards separated.

The unbroken kernels of milled or cleaned rice are known as head rice. This kind of rice always commands the highest price and is sold under several grades, which vary in the different markets but are separated largely according to the brilliancy of the polish and the color and size of the kernels. The broken kernels may be

² *Phalaris paradoxa* L.

sold as ordinary or broken rice, screenings, or brewers' rice. The last grade is composed of very fine particles of the kernels.

The principal feeds that are obtained from rice are bran, meal, and polish. The bran is composed of the seed coat and the embryo, with varying quantities of hulls. Bran that contains no hulls or comparatively few is called meal. It is the most nutritious of the rice feeds and when fresh is very palatable to domestic animals. On account of its high percentage of fat it often becomes rancid if kept too long. In the polish the percentage of fat and protein is much lower than in the meal, while the percentage of starch is much higher. Polish is used for feeding cattle and pigs.

FARMERS' BULLETIN 1142
UNITED STATES DEPARTMENT OF AGRICULTURE

GROWING CRIMSON CLOVER



C **CRIMSON CLOVER** is a handsome fall-planted annual, widely cultivated in the Middle Atlantic and Southeastern States for forage, a cover crop, and green manure.

Crimson clover is commonly sown in corn at the last cultivation. If the soil is heavy, a better practice is to sow after a crop of small grain or on other land which can be specially prepared.

Crimson clover will grow on poorer soil than most clovers and is not particularly dependent upon lime. For this reason it has been widely used for restoring the productivity of soils which have been abused. A more important function is to maintain crop yields on soils which are already moderately rich.

The most common difficulty in growing crimson clover is the killing of the young stands by drought. This is best prevented by the preparation of a fine, moist, and firmly compacted seed bed.

August and September are the best months for sowing crimson clover, the exact date depending upon the condition of the soil. Either hulled or unhulled seed may be used, the latter giving somewhat greater certainty of a stand.

Crimson clover is often sown with a nurse crop of buckwheat or cowpeas, to protect it from the sun. A light covering of straw is also effective.

Combinations of crimson clover with oats, hairy vetch, or other fall-sown forage crops give somewhat higher yields and a surer stand than crimson clover alone.

No insects trouble crimson clover seriously, and the only severe disease is the stem-rot, or wilt.

Contribution from the Bureau of Plant Industry

WM. A. TAYLOR, Chief

Washington, D. C.

August, 1920

GROWING CRIMSON CLOVER.¹

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C RIMSON CLOVER is an annual or winter annual true clover, resembling common red clover in size and general appearance, the most noticeable difference being the flower heads, which are long, narrow, and pointed instead of short, spherical, and compact (fig. 1). The individual flowers of this clover are commonly of a rich scarlet color, and as the heads are borne mostly on the ends of the stems, a field of crimson clover in full bloom presents a strikingly brilliant appearance. Because of the color of the flowers, crimson clover is often termed "scarlet clover," although it is also known, less commonly, as "French clover," "Italian clover," "German clover," "incarnate clover," and "annual clover." It is the only annual true clover that is of more than incidental agricultural importance in the eastern United States.

Probably the most important characteristic of crimson clover is its ability to grow and make its crop during the fall and early spring, when the land is not occupied by the ordinary summer-grown crops. In sections where it succeeds, it can be sown following a grain crop or in an intertilled crop in late summer and is ready to harvest for hay, to pasture, or to turn under as green manure in time to plow the land for spring-seeded crops, such as corn or cotton. South of central Delaware it may even be cut for seed and the stubble plowed under in time for seeding a quick-maturing strain of corn. Because it can be grown during the offseason of the year, crimson clover is one of the most economical legumes for green manuring, and it has

¹ This bulletin is a revision of Farmers' Bulletin 550, entitled "Crimson Clover: Growing the Crop," by J. M. Westgate, formerly Agronomist in Charge of Clover Investigations, Office of Forage-Crop Investigations. The illustrations and some of the subject matter of the old bulletin are retained in the present issue.

been largely used for that purpose in the regions to which it is adapted. The many uses to which this crop may be put merit a careful study of the best methods of establishing a stand of this clover on the farm.

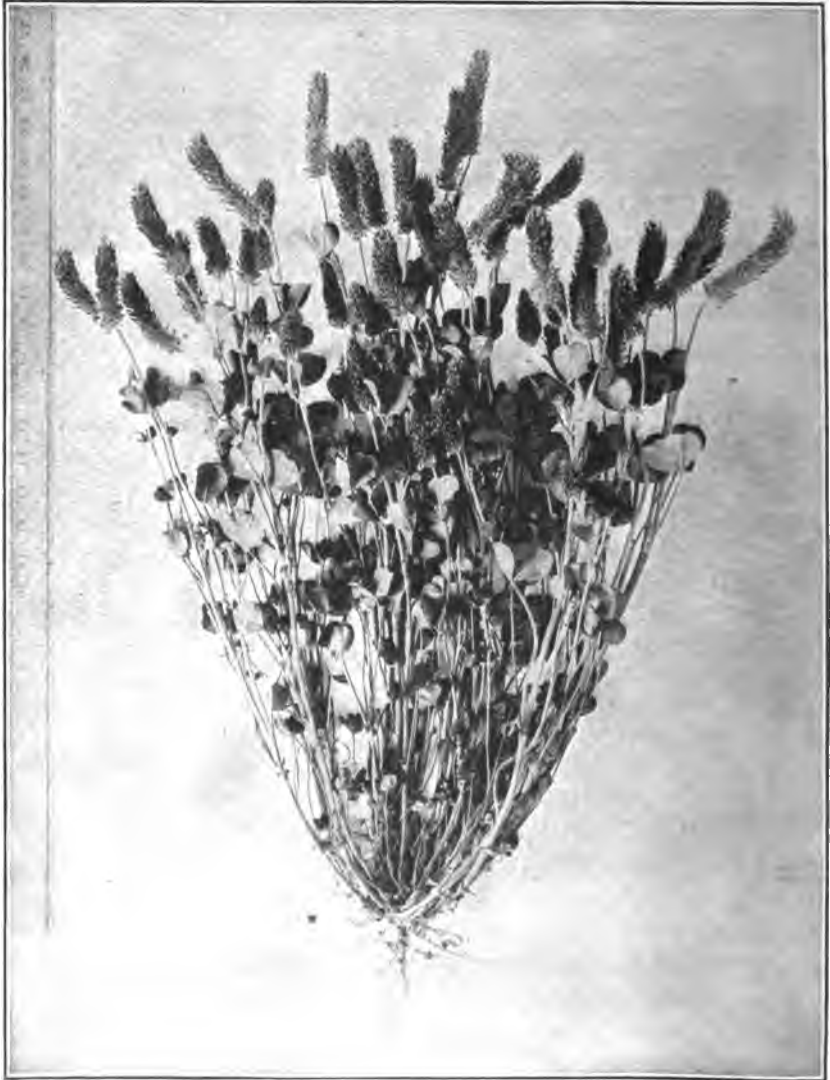


FIG. 1.—A single plant of crimson clover.

HISTORY AND ADAPTATIONS.

Crimson clover is a native of Europe, where it is cultivated as a forage and green-manuring crop in Italy, France, Spain, Germany, Austria, and Great Britain. Large quantities of crimson-clover seed

are exported from Europe to the United States, especially from the districts of central France, where crimson clover is the premier leguminous forage plant.

Crimson clover was introduced into this country as early as 1818, and the seed was widely distributed by the United States Patent Office in 1855. The plant was at first regarded more for its ornamental value than as a forage plant, however, and it was not until about 1880 that its value for agricultural purposes began to be appreciated.

At present crimson clover is grown most widely in the lighter sandy areas of the Atlantic Coastal Plain, where the soil is not very rich and the winters are not severe. (Fig. 2.) The plant does not withstand either extreme cold or extreme heat, and its culture is therefore limited to regions which enjoy at some time during the year a long period of relatively mild, moist weather. Ordinarily, this clover does not survive the winter in latitudes north of southern Pennsylvania, while in some of the Southern States it is frequently killed by dry, hot weather in the fall

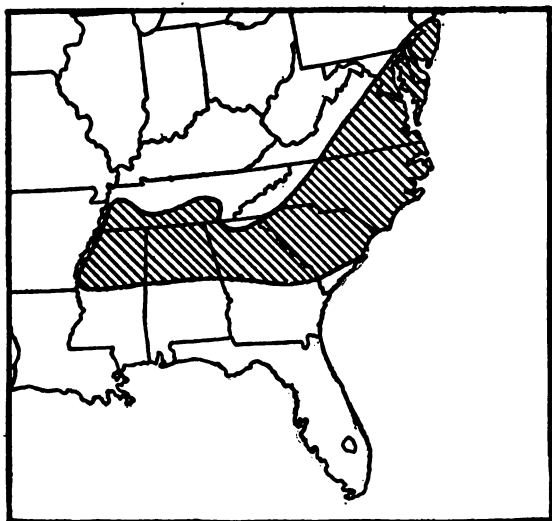


FIG. 2.—Map of a part of the United States, showing the region where crimson clover is most widely grown.

or spring. It succeeds well in the humid regions near the Gulf of Mexico and in the Pacific Northwest, but in these areas it is not widely grown.

Normally, crimson clover is a winter annual comparable to winter wheat; that is, it is planted in the fall, lies more or less dormant over winter, grows rapidly in the spring, and dies, after going to seed, early in the summer. Where the summers are not too hot it can be planted in the spring and grown as a summer crop, but for this purpose other clovers are usually preferred.

VARIETIES.

Crimson clover is exceedingly variable both in color of flower and in time of maturity. These variations are particularly noticeable in fields planted from a mixed lot of seed, the flowers presenting a range in color from nearly pure white to a deep purplish red and the

seeds a difference in date of ripening of more than a month. Since crimson clover is thought to be mainly self-pollinated, it is easy to fix these qualities by selection and to establish definite varieties.

In Europe six or seven different varieties of crimson clover are recognized and sold by seedsmen, varying from extra early crimson flowered to extra late white flowered and from very hardy to non-hardy. By the use of a succession of these varieties the European farmer is able to spread his harvest over six or seven weeks instead of having it concentrated within a few days, as in America. Similarly, the culture of the plant has been extended northward from Italy to Sweden by means of hardy strains. A wild form of crimson clover having yellowish flowers and hairy foliage occurs in southern and eastern Europe and in England, but it is not of economic value.

In America no sharply defined varieties of crimson clover are recognized, except a white-blooming variety which is sold in the South and is two weeks later than the ordinary crimson-flowered sort. Hardy strains have been developed and used in a small way in Massachusetts and Ohio, but these are not commercially available.

USE IN THE ROTATION.

SEEDING IN INTERTILLED CROPS.

In former years a large percentage of the crimson-clover acreage was seeded in corn or other intertilled crops at or shortly after the time of the last cultivation. In most of the crimson-clover area it is possible to make such a seeding, obtain a good growth during the fall and early spring, and mow or plow under the clover in time for breaking up the land for another crop of corn. This has been the standard method of growing this clover, and it is still the leading practice in many of the older sections. Corn in the summer with crimson clover in the winter is a cheap and convenient method of growing a cash crop and a restorative crop the same year, and the reputation of crimson clover as a crop increaser is largely based on this simple rotation. Instances are by no means rare where the yield of corn has been gradually increased from 10 bushels per acre to as high as 70 bushels by this means.

The difficulty with this method is the possibility of the stand of young clover failing through drought. The growing corn makes a heavy demand on the soil moisture, and if there is not enough moisture for both clover and corn the latter gets the larger share and the tender clover plants are likely to succumb. Because of the risk involved, farmers in the upland sections are seeking other and more reliable methods of seeding, and the sowing of crimson clover in corn is gradually decreasing.

Where the danger from fall drought is not serious, crimson clover may be sown in corn at the time of the last cultivation or when the corn leaves have just begun to wither. South of central Virginia there is likely to be much hot weather after the corn is laid by, in which case it is best to delay the seeding of the clover until after the first rain. The appearance of a field of crimson clover seeded in corn the previous summer is shown in figure 3.

South of southern Virginia crimson clover can be seeded in cotton, provided the field is free from crab-grass and other weeds and the soil is not too dry. In the extreme north of the cotton belt the seed may be sown at the last working of the cotton; farther south this occurs too early and it is necessary to wait for a rain, which often comes at about the time of the first picking.

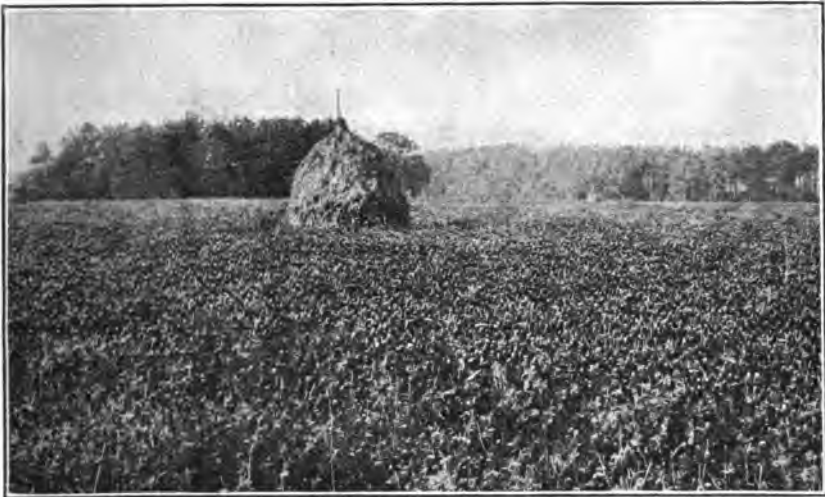


FIG. 3.—Crimson clover in an old cornfield. The clover was seeded in the corn at the last cultivation. A fodder stack is to be observed in the middle foreground. The cornstalks have been removed to avoid difficulty in mowing the clover.

Crimson clover may be seeded in practically any of the cultivated truck crops which receive their last cultivation from 8 to 12 weeks before the first frost. It is not practicable to seed the clover in late potatoes, sweet potatoes, or other root crops, as the digging in the fall practically destroys the clover.

Ordinarily, crimson clover does not succeed when sown in cow-peas, sorghum, or watermelons, owing to the heavy shade cast by these crops. It can, however, be seeded in tobacco, tomatoes, cultivated soy beans, and cantaloupes.

SEEDING AFTER AN EARLY-MATURING CROP.

Seeding crimson clover in an intertilled crop is successful mostly on sandy soils, which can easily be prepared for seeding even in mid-summer. On clay soils and in weedy fields this method of seeding

is likely to be unsatisfactory. Such soils are usually hard and dry in August and can with difficulty be brought into condition for a seed bed, with the result that a large percentage of such seedings fail. A better plan on clay soils, and on sandy soils in many cases, is to seed the crimson clover on specially prepared ground from which all other crops have been removed. Such ground can be made as fine and firm as desired. Furthermore, the clover after planting does not have to compete with another crop for the soil moisture. This method is somewhat more troublesome than planting in intertilled crops, but the greater certainty of getting a stand more than offsets the greater cost. Planting crimson clover on specially prepared ground has extended the culture of the plant to regions where it was not hitherto grown and is increasing the reliability of the crop in sections where it has been long established.

In the ordinary rotation, crimson clover follows a crop of small grain. However, it may follow any crop that is removed 8 to 10 weeks before frost, or it may be seeded on fallow ground. Ground from which early potatoes have been removed is especially favorable for the establishment of a stand of this clover. The residual effect of the fertilizers used on potatoes is partially responsible for this, while the well-settled seed bed, which requires only leveling and harrowing, also presents favorable conditions for the crimson-clover seedlings.

In many parts of the South crimson clover can be seeded in corn stubble if an early variety of corn has been used. Although there is some risk that the clover may not make enough growth before winter if seeding is delayed until the corn is harvested, the danger of losing the stand is not as great as if the clover were seeded earlier, while the corn was standing.

Crimson clover is sometimes seeded after a grass or clover crop if the rainfall in July is sufficient to cause the sod to decay. In the far South it can be planted after peanuts, while in all sections it can be sown as a catch crop on land where cotton or other crops have died early in the season.

REQUIREMENTS FOR OBTAINING A STAND.

Probably the difficulty most commonly experienced in growing crimson clover is failure to obtain a satisfactory stand. Sometimes the seed does not germinate well; more commonly good germination is secured, but the seedlings wither and die before they can become established. Frequently not more than 50 per cent of the plants survive the first three weeks, while a complete failure of the crop is a common risk even in the sections where crimson clover is most widely grown.

The most common cause of failure to obtain a stand is hot, dry weather after planting. The seedlings of crimson clover are tender,

succulent, and shallow rooted and are easily killed by lack of moisture. Unfortunately, in most of the crimson-clover area the weather during late August and early September is very likely to be hot and droughty, making the planting of the clover at that time rather hazardous. Some farmers attempt to avoid this difficulty by planting either in early summer or in October, after the fall rains; there is danger, however, that the plants will make too much or too little growth to survive the winter. In the long run it is probably better to plant at the regular time and depend upon thorough preparation of the seed bed to offset any deficiency in the rainfall.

SOILS.

Crimson clover can be grown successfully on almost any type of soil if it is reasonably rich, well drained, and supplied with organic matter and the proper inoculating bacteria. Probably two-thirds of the crimson-clover acreage is found on the sandy soils of the Atlantic Coastal Plain, but the crop is not necessarily restricted to sandy



FIG. 4.—A crimson-clover failure on ground too poor in humus.

increasing in importance on the red-clay soils of the Piedmont region and in the limestone valleys of Virginia and Tennessee.

Crimson clover has been an important factor in increasing yields on soils that have been abused, but it is not a crop for land which is naturally very poor. It does not do well on rough, newly cleared

areas, raw subsoil, hard, dry clay, or sterile sand. (Fig. 4.) For such soils soy beans, cowpeas, and velvet beans are better suited and should be used for the first three or four years until crimson clover can be successfully grown. Crimson clover can be made to grow on poor soils, provided they are specially prepared by liming, manuring, and inoculating. In general, however, crimson clover is a crop for maintaining soils which are already fairly productive rather than one for inducing productivity in soils where it is quite lacking. If there is any doubt whether the soil is suitable for crimson clover, a small plat should be prepared under field conditions and planted one year for trial.

PREPARATION OF THE SEED BED.

To secure a full, even stand of crimson clover with any degree of regularity the seed bed should be well and thoroughly prepared.

The soil should be firm, moist, well settled, and fine on top. Only indifferent success can possibly be expected if the seed is scattered on

land which is loose, dry, and full of hard lumps and trash. A loose seed bed dries out quickly, heaves during the winter, and on some soils blows and washes badly.

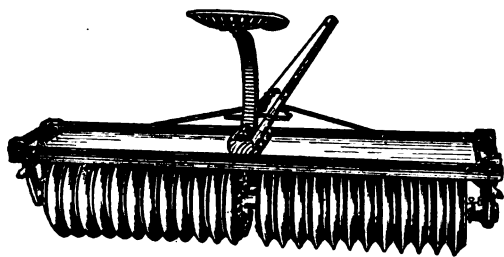


FIG. 5.—A corrugated roller or pulverizer, an excellent implement for preparing the seed bed for crimson clover.

On the other hand, the seed bed should not be too hard, for although this clover often grows successfully on soil which

would be too solid for corn, there must be at least enough loose soil on the surface to cover the seed. Thorough preparation is the very best insurance against failure of the stand through drought or winter-killing, and the most successful growers sow crimson clover on land as well prepared as that for wheat.

To secure a fine, firm seed bed without drying out the surface soil, the land should be prepared with as few operations as possible. A single working when the soil is in a moist, crumbly condition is better than half a dozen workings when the soil is too wet or too dry. In very sandy soils, or soils which do not form a crust, the only preparation needed is to keep down the weeds.

An excellent tool for making the seed bed is the corrugated roller or pulverizer (fig. 5). This implement is an improvement over the old plain roller for breaking clods and is unexcelled for keeping the surface soil moist. It can be used after plowing and again before planting, and even after planting if the soil needs to be compacted. Rolling of some kind to firm the soil is especially important on sandy soils, but it is equally beneficial on clay soils if they are cloddy.

When clover is seeded in an intertilled crop, such as corn, cotton, or tomatoes, the customary cultivation received by these crops is ordinarily sufficient preparation for crimson clover. In sandy soil the clover is often seeded without any immediate preparation, but a light stirring with a harrow-toothed cultivator is desirable if the ground is hard. If the clover is to be used for hay or seed, the preceding crop should be laid by level rather than in ridges. This will facilitate cutting the clover.

Where crimson clover is seeded after a crop of small grain, the stubble should be plowed or disked as soon as possible after the grain is cut. Stubble land dries out quickly, partly because the soil is suddenly left bare and partly because of the drain on the soil moisture by the crops of ragweed and other coarse-growing weeds which always follow a grain crop. Unless the soil is cultivated at once it becomes very difficult to obtain anything like an ideal seed bed for crimson clover. This difficulty is usually more pronounced after oats and barley than after rye and wheat. Ordinarily the best practice is to disk the grain stubble within a week after harvest and harrow every week, or at least after every rain, in order to settle the ground, destroy the weeds, and assist in holding the moisture pending the time of seeding the clover. Plowing the stubble is more expensive than disking and requires that the ground be allowed to settle for a month or six weeks in order to secure a firm seed bed. Plowing is an advantage in a wet season, because plowed ground dries readily; it is a disadvantage in a dry season for the same reason.

FERTILIZERS.

On moderately rich soil the fertilizer applied to the preceding crop is sufficient to produce a good crop of crimson clover. This is especially true where the clover follows such crops as potatoes or tomatoes, which ordinarily are heavily treated with fertilizers. It is important to realize, however, that crimson clover has a very short period of growth, and that to make a vigorous growth it must have a good supply of plant food. On sandy soils where fertilizers have not recently been applied it is often the practice to apply from 150 to 200 pounds of acid phosphate, with some potash fertilizer if it can be afforded. On clay soils 200 or 300 pounds per acre of acid phosphate ordinarily are sufficient. On many soils a light application of nitrate of soda will assist materially in giving the young clover plants a good start and often will enable them to withstand the effects of a late drought or severe winter which otherwise might have injured the stand. If the seeding has been delayed, as by waiting for suitable rains, an application of not more than 75 pounds of nitrate of soda per acre will stimulate the young plants and enable them to make a better growth before winter.

Fertilizer is usually applied at seeding time, but a few farmers have been found who apply it as a top-dressing very early the following summer, giving as a reason that there is then no loss from winter leaching and that by this method the plants are nourished at the time they are making their most vigorous growth. Such top-dressings of fertilizer should not be made while the leaves are wet with rain or dew. Where stable manure is applied to crimson clover very marked results follow. It may be spread just before seeding when the clover is not grown in an intertilled crop, or it may be applied as a top-dressing in winter or very early spring.

The more vigorous the growth that can be induced by the application of suitable fertilizers the more marked will be the increase in the yield of the succeeding crops. On soil in a low state of productivity the use of a reasonable amount of fertilizer will often enable a successful crop of clover and succeeding crops to be produced, where had not the fertilizers been applied the clover would have failed. Furthermore, the following crop, particularly if it be corn, would also fail to give the increased yield which follows a successful stand of crimson clover.

An application of barnyard manure will be found to be especially effective in obtaining a stand of crimson clover on any thin, galled spots in the field. The manure should be worked into the ground before seeding, and, if possible, a second application as a top-dressing should be given a day or two after planting. The top-dressing stimulates the seedlings and if strawy helps to protect them from the August sun.

LIME.

Crimson clover is not as dependent on lime as red clover and alfalfa, being more like alsike clover in this respect. It does not thrive on soils which are very "sour," but on well-drained soils in a productive condition crimson clover frequently makes a vigorous growth, even though the soil may show a high lime requirement. The stands are usually more uniformly good over the limed parts of such fields than on the unlimed parts, although it is sometimes questionable whether the benefit derived from liming is profitable. Liming is more often desirable on clay soils than on sandy soils, and usually gives better results when used in conjunction with fertilizers than when used alone. On light sandy soils deficient in humus burnt lime may be actually injurious. In considering the advisability of applying lime one must not lose sight of the need of lime on the part of such other crops as corn, cantaloupes, or peaches, which are either grown with or follow the clover. Inasmuch as the effect of liming varies greatly in different localities, it is suggested that small plats be treated experimentally at different rates before any considerable areas are limed.

INOCULATION.

A large part of the value of all clovers lies in their ability to utilize the nitrogen of the air and add it to the soil. When grown on rich land, the clovers, like many other plants, use the nitrogen already present in the soil and are not stimulated to contribute any to their own support or to the support of other crops. To enable the clover to use the nitrogen in the air the presence of the proper nodule-forming bacteria in the soil is necessary.

Fortunately, most of the soils in the crimson-clover sections appear to be already inoculated, and artificial inoculation is not often necessary, except on soils new to the crop. Crimson clover is inoculated by the same strain of bacteria which occurs on the roots of the other true clovers; consequently, a field which has produced a good stand of red, mammoth, alsike, white, hop, Carolina, rabbit's-foot, or buffalo clover is usually inoculated sufficiently for crimson clover. Sweet clover, Japan clover, and bur clover are not true clovers and are inoculated by a different strain of bacteria.

The importance of inoculation is well shown by an experiment conducted by the Alabama Agricultural Experiment Station. In this experiment yields of 4,057 and 6,100 pounds of crimson-clover hay were secured on inoculated soils, while on corresponding areas which were not inoculated the yields were 761 pounds on one area and nothing on the other.

The soil can be inoculated artificially by means of pure cultures of the bacteria or by the transfer of a small quantity of soil from another clover field.¹ The latter method is the more certain, but is open to the danger of introducing noxious weeds, insects, and plant diseases, especially if the soil is brought from a distance. The presence of stem-rot in many sections makes the use of soil especially dangerous. This disease can be carried with the soil from field to field.

SEEDING.**TIME OF SEEDING.**

Crimson clover is usually sown between August 15 and October 1, the general rule being to plant about 60 days before the first killing frost is expected. South of Virginia crimson clover can be seeded as late as November 1, although if planted late more seed should be used and a light dressing of nitrate of soda applied, in order to stimulate the young plants. Seeding earlier than August 1 is seldom advisable unless the crop is sown with some other crop the shade of which will hold it back.

¹ Sufficient pure culture for inoculating seed for 1 acre can be secured free from the United States Department of Agriculture. Full directions for using the culture accompany each bottle. Directions for inoculating by the soil-transfer method can also be obtained from this Department.

The exact date of planting depends almost entirely upon the moisture content of the soil. The principal condition to avoid is planting when the soil contains just enough moisture to germinate the seeds, but not enough to keep the plants growing. Usually it is better to plant when the soil is quite dry than when it is slightly moist, for in dry soil the seeds, if properly buried, lie without germinating and are ready to grow vigorously at the first rainfall. The most favorable time for seeding is just before or just after a good rain, when the soil is moist enough to form a ball in the hand.

RATE OF SEEDING.

The ordinary rate of seeding crimson clover is 15 pounds per acre, although the rate varies according to conditions. From 12 to 15 pounds per acre are usually sufficient when growing the crop for seed or when the soil is unusually rich. On poor soil, dry soil, or on soil which has not previously produced crimson clover 18 to 22 pounds of seed give better assurance of a stand. Heavy seeding is also desirable when planting late in the season or when a heavy crop is wanted for green manure early in the spring.

Theoretically, 2 pounds of seed per acre would provide six plants for every square foot, which is a satisfactory stand. Under ordinary circumstances, however, it is necessary to allow for some of the seed being too deep, or too shallow, or failing to germinate, and for a certain percentage of winterkilling. It is also well to have a fairly thick stand of the young plants, so that the ground may be well covered during the early fall and thus prevent soil washing and the growth of winter weeds.

METHODS OF SEEDING.

The most common method of seeding crimson clover in intertilled crops is to scatter the seed broadcast with a rotary seeder or by hand. (Fig. 6.) In order to place the seed on a fresh, moist seed bed it is commonly broadcasted immediately behind the cultivator at the last cultivation and is covered at once by a second cultivator. In tall corn the seed may be sown from horseback, the ears of the horse being covered with small bags to prevent the entrance of the flying seed. Slightly more seed is required when seeding in tall corn, as some seed catches in the corn plants. When seeding in cotton care must be taken to avoid injury to the opening bolls, which are easily knocked off or torn. This is best done by seeding by hand, covering the seed with a piece of brush dragged down the rows.

In low-growing truck crops and on fallow ground crimson clover can be seeded with a wheelbarrow seeder. This implement distributes the seed more evenly than can be done by hand or with the rotary seeder, especially when planting a mixture of crops. The wheel-

barrow seeder being somewhat awkward to handle is better adapted to smooth, level fields than to hillsides.

Probably the very best method of seeding crimson clover is with the special clover or alfalfa drill. Where enough clover is grown to warrant its use this implement is to be highly recommended. The seed is sown in 4-inch rows at just the proper depth and with the right pressure, and the fertilizer is placed exactly under each row, where it will be immediately available to the seedlings. Drilled clover requires less seed than broadcasted clover and produces a more even and certain stand.

In place of the special clover drill an ordinary grain drill equipped with a clover-seed attachment can be used with good results. Special spouts should be arranged to lead from the clover-seed box back of



FIG. 6.—Seeding crimson clover in corn at the last cultivation.

the shoes or disks, in order to deposit the seed directly in the furrow. Chain furrow closers are best for covering the seed, as they leave the furrows broad and flat instead of V shaped and lessen the danger of the seedlings being covered with soil during a hard rain.

For use in intertilled crops there are several types of 1-row drills, the best for this purpose being the 5-hoe drill equipped with press wheels.

Crimson-clover seed must be covered, but not too deeply. In most soils it is not enough to depend on rain to effect a covering. An inch in sandy soils and half an inch in clay soils appear to be about the right depth. Shallow planting gives the best results in wet seasons and deep planting in time of drought. Broadcasted seed should be covered with a spike-tooth harrow or a weeder rather than a heavy harrow or a shovel cultivator. A harrow made of fairly stiff brush is often useful in loose soil.

CHOICE OF SEED.

As a rule, fresh crimson-clover seed is of good viability, and failure to secure a stand is not often caused by failure of the seed to grow. Unlike most clovers, crimson-clover seed absorbs water readily and sprouts quickly. There are practically none of the hard seeds which are so frequent in red clover and sweet clover, and a germination of 90 per cent in 48 hours is not uncommon. The seed deteriorates rapidly, however, and when more than 2 years old rarely shows a germination in excess of 50 per cent. Sometimes, when stocks of commercial seed are low, old seed finds its way to the market, and this, when planted, gives poor results. Old seed can usually be detected by the dull-brown appearance of the seed coat as contrasted with the bright, shiny, pinkish or greenish yellow color of fresh seed. Brown seed, however, is sometimes caused by weathering during harvest, and such seed is not objectionable unless the weathering has been excessive.

A common impurity in crimson-clover seed is green, shrunken, and immature seed, caused by harvesting the crop before it is ripe. Crimson-clover seed does not germinate readily until it takes on a yellowish tinge; therefore, green seed should be rejected.

Crimson-clover seed is larger and plumper than red-clover seed and if properly cleaned should not contain seeds of dodder or the smaller seeded weeds. Frequently, however, it does contain the seeds of field peppergrass, yellow trefoil, evening primrose, sheep sorrel, wild geranium, buttercups, mustards, and other weeds which blossom in early summer.

UNHULLED SEED.

There is a growing belief among farmers that they are less likely to lose a stand of crimson clover through drought if they sow the seed in the hull rather than use the hulled seed as it ordinarily appears on the market. It is claimed that the hulls hold the moisture to some extent and carry the seedlings over the critical day or two following germination, while some farmers assert that the unhulled seeds require more moisture for germination, and the seeds therefore do not sprout until there is enough moisture in the soil to keep the plants growing. Unhulled seed is bulky and is not often handled by commercial seedsmen, although one large grower sells the unhulled seed in compressed bales similar to small cotton bales. It usually can be secured from neighboring farmers, however, or is easily saved at home. The seed can be harvested with a stripper from the standing crop in the field or the mature crop can be cut and thrashed like an ordinary grain crop. For local planting on a small scale unhulled seed is the cheapest and most accessible form of crimson-clover seed.

Unhulled seed is somewhat difficult to sow, because the hairy hulls stick together in masses and can not be scattered uniformly. To avoid this trouble the seed may be mixed with moistened earth or with lime, or may be sown with a blower similar to those used on small forges. A better plan is to sow on a windy day, throwing the seed vertically into the air and allowing the wind to scatter it.

Of unhulled seed of the best quality, 100 pounds contains about 1 bushel (60 pounds) of clean seed. The common grades, however, are usually more chaffy and require 120 to 180 pounds to make a bushel. From 2 to 3 pounds of unhulled seed are therefore regarded as equivalent to 1 pound of hulled seed. A bushel of unhulled seed, even when

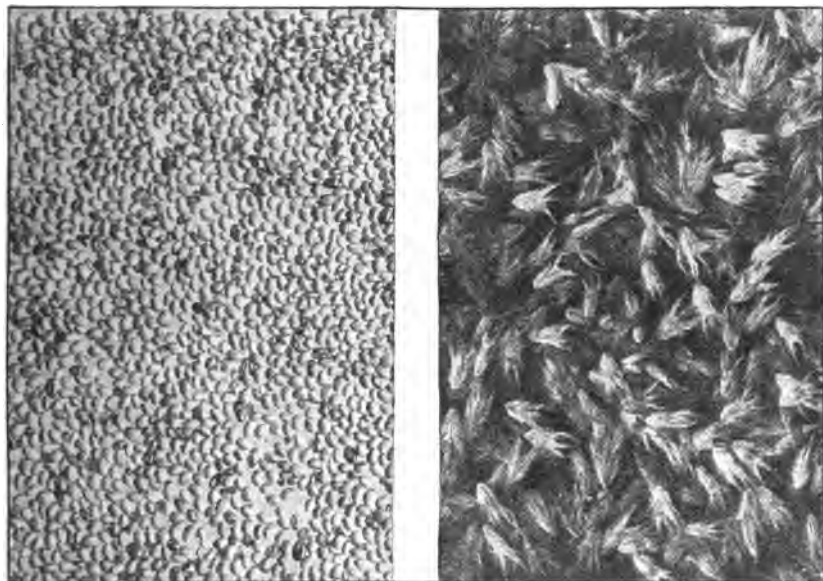


FIG. 7.—Hulled seed of crimson clover of a common commercial grade and unhulled seed gathered with a homemade stripper. (Natural size.)

well packed down, weighs only 6 to 10 pounds and contains about 4 pounds of seed. The appearance of both hulled and unhulled crimson-clover seed is shown in figure 7.

USE OF A NURSE CROP.

In order to protect the crimson-clover seedlings from the hot sun of late August it is a common practice in some sections to plant with the clover a small quantity of some quick-growing crop like buckwheat, cowpeas, rape, or turnips. A thin stand of these heavier leaved plants furnishes an ideal shade for the young clover, and on soils which are inclined to bake it prevents the formation of a crust. The nurse crop must be seeded lightly, usually not more than half the regular rate, as the ordinary stand shades the ground so com-

pletely as to destroy the crimson clover. On hot clay soil in the Piedmont region the chances of obtaining a stand of clover are about twice as good with a nurse crop as without one.

Buckwheat is the principal nurse crop northward from Washington, D. C. A common rate of seeding is 2 to 3 pecks of buckwheat in 15 pounds of crimson clover. If the planting can be made in July the buckwheat usually has time to ripen before frost and thus pay the cost of starting both stands.

In the cotton belt cowpeas have been used successfully, especially when seeding on fallow ground. They are seeded broadcast at the rate of one-half bushel per acre. There is ordinarily not enough time for the cowpeas to mature, but they add to the value of the stand for fall pasture and protect the clover from severe weather in the winter. Both cowpeas and buckwheat have the merit of being able to grow on poor soil.

Dwarf Essex rape has been used as a nurse crop in a few cases where the clover was to be pastured by hogs or sheep in the fall. From 2 to 3 pounds of rape, sown in August, furnishes sufficient cover for a nurse crop. Cowhorn turnips, winter kale, and mustard are also satisfactory nurse crops if planted at a rate not exceeding 1 pound of seed per acre. If the clover is to be saved for seed these latter crops are objectionable, as a few plants will live over winter and ripen at the same time as the clover.

Where a nurse crop can not be grown conveniently, the crimson-clover seedlings can be protected from the sun by a light top-dressing of straw, spread just after the seed is sown.

SEED MIXTURES.

Crimson clover is frequently grown in combination with winter grain, hairy vetch, or other forage crops having a similar period of growth. The mixed crop is less liable to lodge than the single crop, cures more readily in damp weather, and usually furnishes a heavier yield. Another advantage of the mixed crop is that if either should fail the other will serve as a cover crop during the winter and bring some return the following spring. Mixed crops are not desirable if the clover is to be saved for seed.

South of central Virginia crimson clover is usually grown in combination with winter oats. An early variety of oats, such as the Fulghum, or a late variety of clover, such as the white blooming, is usually the best, as the oat crop matures somewhat later than the ordinary crimson clover. The customary rate of seeding is 15 pounds of the clover and 2½ bushels of oats per acre. In Delaware and eastern Maryland the most popular companion crop for crimson clover is winter wheat, although barley makes a desirable hay crop and is sometimes used. Rye is not desirable for hay, but it is prob-

ably the best of the grains for green manure, as it is hardy, vigorous, and starts growth early in the spring. Rye and wheat are seeded at the rate of 1 bushel per acre with the customary quantity of crimson clover. The accompanying illustration (fig. 8) shows a field seeded to a mixture of crimson clover and wheat. Usually the grain is well headed, but in the milk or soft-dough stage, when the clover is ready to cut, the yield of the mixed crimson clover and grain is often 25 to 50 per cent greater than that of the clover alone.

Hairy vetch and crimson clover are sometimes grown together, seeding at the rate of 20 pounds and 10 pounds per acre, respectively. As both these plants are likely to lodge in good soil, however, one of the grains is usually included, a common seeding mixture being oats 2 bushels, hairy vetch 12 to 15 pounds, and crimson clover 5 pounds. Bur clover, black medic, and other winter-growing legumes are sometimes found in mixtures with crim-



FIG. 8.—Crimson clover and wheat in mixture. In the foreground the crop has been cut and fed green to stock. The remainder was cut the next day for hay. The grain prevents the crimson clover from lodging.

son clover, although such mixtures generally occur by accident rather than intent. Black medic and crimson clover make a particularly good combination on rich soil.

In most of the crimson-clover area the cultivated grasses, such as timothy, redtop, and orchard grass, are not commonly grown. However, where these grasses flourish they may well be seeded at the same time as the crimson clover, provided the latter is planted not earlier than September 15. In some sections Johnson grass and Bermuda grass make useful combinations with crimson clover, the grasses making most of their growth in the summer and the clover in the fall and spring.

TREATMENT OF THE STAND.

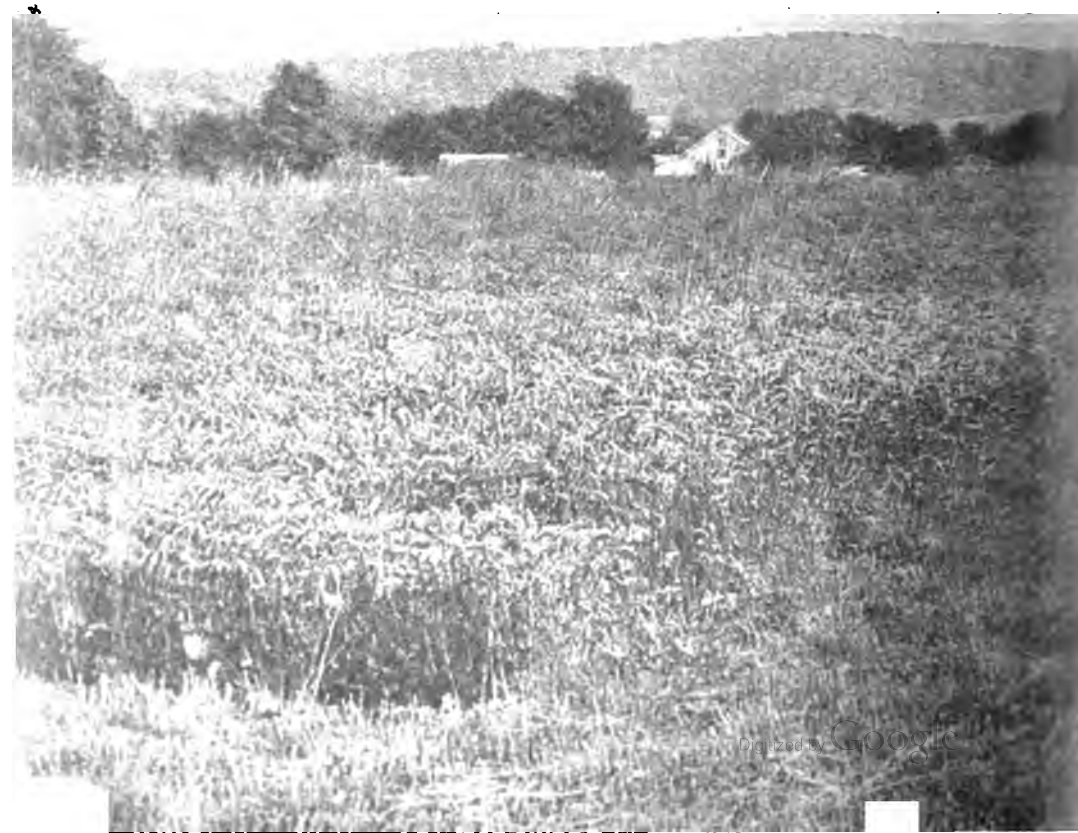
Ordinarily no special treatment is required after seeding and the clover goes into the winter without any further handling. If the growth is so rank that there is danger of the plants being too succulent to survive the winter, the tops can be reduced by light grazing with small animals, such as calves, sheep, or chickens, or by mowing with the cutter bar of the mowing machine set high. If the stand is backward, it may be stimulated by a light application of nitrate of soda. It is said that a thin stand can be thickened by grazing lightly with sheep, as the grazing induces heavier stooling. The aim should be to carry the clover into the winter with well-hardened leafy stems and with a well-established root system to withstand heaving out in the spring.

In fields which are to be saved for seed a wise precaution is to go over them early in the spring and chop out the weeds. If wild onion and other weeds are chopped off in April, they do not make enough growth by May to contaminate the seed crop.

MALADIES.

The only disease seriously affecting crimson clover is the clover stem-rot, root-rot, or wilt, a disease resembling the stem-rot, or wilt, of lettuce and other plants. This disease is prevalent in nearly all the crimson-clover States and sometimes does considerable damage. The stem-rot affects the clover at all seasons, but is more noticeable in the spring, when it sometimes causes large spots of clover suddenly to wilt and fall. Occasionally an entire field is affected, but the disease is most prevalent in low, rich spots. Examination of the plants discloses a rotting off or decay of the stems close to the ground, followed immediately by the appearance on the stems of small black lumps, or sclerotia, about the size of clover seed. These sclerotia are a means of spreading the disease and are often harvested in the hay or in the seed crop. The only known remedy for the stem-rot is to cease growing clover or alfalfa on an infested field for three or four years, substituting cowpeas or soy beans. Seed from fields known to be infested should, of course, be avoided.

No insects are known to affect crimson clover seriously, nor are weeds of great importance in clover planted on clean fields. When planted in cultivated crops or in poorly prepared ground crimson clover is often seriously damaged by a rank growth of chickweed, knawel (moss weed), winter cress, and other winter-growing annuals.



FARMERS' BULLETIN 1143
UNITED STATES DEPARTMENT OF AGRICULTURE

LESPEDeza AS A FORAGE CROP



LESPEDEZA, or Japan clover, is one of the most valuable forage plants of the southeastern part of the United States.

Lespedeza produces a good hay crop on rich bottom lands.

The chief use which should be made of lespedeza is as a constituent in permanent pastures of Bermuda grass and carpet grass.

Lespedeza thrives on a great variety of soils and has a beneficial effect on the crops which follow it.

Although an annual plant, lespedeza will reseed itself even under grazing conditions.

Lespedeza is recommended for use in crop rotations wherever it makes sufficient growth to be cut for hay.

Oats may be harvested and a crop of lespedeza either for hay or seed grown on the same land in one season.

Contribution from the Bureau of Plant Industry

WM. A. TAYLOR, Chief

Washington, D. C.

August, 1920

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LESPEDeza AS A FORAGE CROP.

LYMAN CARRIER,¹

Agronomist, Office of Forage-Crop Investigations.

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LESPEDEZA,² also commonly known by the name Japan clover, is one of the most valuable forage plants for the southeastern part of the United States. Except on alluvial bottom lands, it does not make sufficient growth to justify its being cut for hay; nevertheless its widespread adaptation to grazing conditions gives it a value that is difficult to estimate. It will grow in open woodlands, on the poorest of upland hills, along roadsides, and in other waste places. Although an annual plant, it produces sufficient seed even under close grazing to reseed itself and is therefore as useful as if it were a perennial. Being a legume, it is valuable for soil improvement, and also it is relished by all classes of live stock. On the southern markets lespedeza hay has been well and favorably known for several years.

The growing of lespedeza should be encouraged in all the pastures of the South, especially in the cut-over pinelands of the Coastal Plain. It may also be utilized to advantage as a hay crop on the rich bottom lands of the Gulf States. It is slow in starting in the spring, but makes its best growth during the hottest part of the summer, when grass plants are likely to be dormant.

HISTORY.

Lepedeza, a native of eastern Asia, was introduced into this country previous to 1846. The exact date of introduction is unknown,

¹ Many of the data for this bulletin were collected by Mr. H. S. Coe, who died Oct. 25, 1918.

² Scientific name, *Lepedeza striata*.

but the popular belief that it was first brought into the South during the Civil War is erroneous, although it then spread to various sections where it had not been known. The first definite record of this plant being found in the United States was in August, 1846, when Thomas C. Porter collected at Monticello, Ga., a specimen now preserved in the Gray Herbarium.

Col. J. B. McGehee, of Laurel Hill, La., probably was the first man in this country to grow lespedeza on an extensive scale, and his efforts and writings greatly stimulated its early cultivation.

DISTRIBUTION.

Lespedeza has gradually spread until it now occurs in more or less abundance from central New Jersey westward to central Kansas and

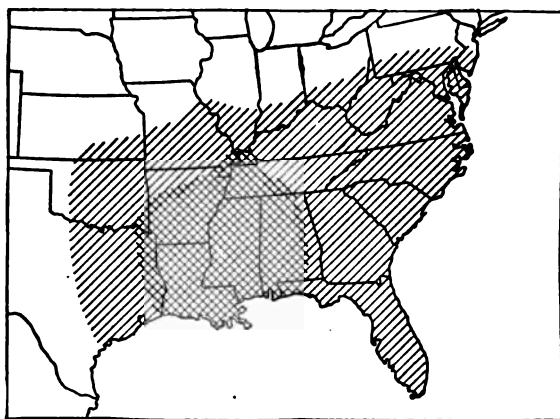


FIG. 1.—Map of the southeastern United States, showing the region where lespedeza thrives. In the section shown by cross shading it is sometimes utilized as a hay crop.

southward to the Gulf of Mexico. (Fig. 1.) It was limited to a small area before the Civil War, but soon afterwards lespedeza was found in many parts of the South. As horses relish lespedeza and as the seeds may pass through the alimentary tract without being destroyed, it is probable that it was widely distributed

during the Civil War by the movement of cavalry. Other animals and also birds may likewise have been responsible for its distribution. There is reason to believe that it has reached its northern limits, as lespedeza requires a hot climate and a comparatively long season to mature.

SOILS SUITABLE FOR LESPEDEZA.

Lespedeza is found growing on all the principal types of soil in the South. As a hay crop it is grown principally on the alluvial soils of the Mississippi River Delta and on the very fertile soils in other sections. (Fig. 2.) It thrives on poor red-clay soils and on the sandy soils of the Coastal Plain, but under such conditions it seldom makes more than 5 or 6 inches of growth; however, even this is a very valuable addition to the pasture, as it often furnishes from 20 to 30 per cent of the total herbage. Where it

has been seeded in pastures or on cultivated land in southern Georgia, Alabama, and northwestern Florida good stands have been obtained, and the plants grow 3 to 10 inches high. It is true that lespedeza has not made much headway on the native ranges in that section, but it is believed that this is due partly to shading by tall grasses and partly to the common practice of burning the ranges each year.

While lespedeza will thrive on soils that are practically devoid of humus, it is believed that with the increase of the humus content of the soil and by a liberal application of phosphorus, the area where it will make sufficient growth to be cut for hay can be greatly extended. Lespedeza requires an abundance of moisture for maximum growth, but the soil should be well drained, as the plants will not succeed



FIG. 2.—Windrowing lespedeza hay with a side-delivery rake at Tallulah, La.

on wet land. The moisture-holding capacity of sandy soils may be increased by increasing the supply of vegetable matter.

FERTILIZERS.

Very little investigation has been made of the value of fertilizers to lespedeza. At the Mississippi Agricultural Experiment Station an application of 200 pounds of land plaster per acre gave a yield of 4,380 pounds of hay per acre, while on the check plat the lespedeza was too short to mow. At the Holly Spring Branch Station in Mississippi, an application of 400 pounds of acid phosphate per acre more than doubled the yield of hay.

For three years the Louisiana Agricultural Experiment Station conducted fertilizer experiments with this crop on rich soils, but the results gave no positive information.

Many farmers have found that phosphoric acid increases the yield of this crop materially. On one farm on the hill lands adjacent to the Mississippi River Delta in Louisiana the growth of lespedeza has been much more than doubled by turning under considerable vegetable matter and applying 400 pounds of raw rock phosphate every third year. When the crop follows cotton it is often possible to determine the location of the cotton rows by the increased growth of the lespedeza as a result of the residue of the fertilizers applied to the cotton crop. On soils that have a high humus content, rock phosphate will probably give as good results as acid phosphate.

Lime has some effect on the growth of lespedeza, but it is questionable whether on the average farm it would pay to apply it for this crop alone, as lespedeza will grow successfully on soils which are too acid for alfalfa or red clover.

TIME OF SEEDING.

Lepedeza is usually sown in the early spring on winter grain, usually oats. It is advisable to use a grain crop with it, as the stand is seldom injured thereby and a crop is obtained from the field in addition to the lespedeza hay. It is doubtful whether the shading by grain would affect the young plants as much as the heavy stand of weeds which would take possession of the land if the grain were not planted, and certainly as much labor would be required to keep the weeds in check as to harvest the grain. Even in the event that a nurse crop is used it will be necessary to mow the weeds before the hay is harvested to obtain lespedeza hay comparatively free from weeds. When the seed is sown without a grain crop on land that has been in cultivated crops for at least the two previous years, the hay is usually free from weeds.

CHOICE OF SEED.

As lespedeza seed is harvested and sold in the hull, much seed is offered for sale that contains an excess of impurities. The principal weed seeds which are mixed with lespedeza seed are crab-grass, rag-weed, paspalums, poverty grass, and spiny sida; and the inert matter most commonly found consists of small particles of soil and portions of the calyx of the flower.

It is often difficult to remove all of the impurities without loss of much of the lespedeza seed. Many fanning mills are not equipped with sieves having meshes of the proper size, but even with properly equipped mills it is necessary to run the seed through them from two to eight times in order to remove most of the impurities. Several firms now manufacture special lespedeza sieves which give satisfactory results, and with these practically all of the inert matter

and most of the weed seeds can be removed. However, seeds which are approximately the same size and shape as the seed pods of lespedeza can not be removed without losing a great deal of the lespedeza seed. Dallis grass (*Paspalum dilatatum*) belongs to the type of seed which is commonly present in lespedeza, but the seed of this plant is not an objectionable impurity when the lespedeza is to be sown in pastures, as it is an excellent and valuable grass. Lespedeza seed that is offered for sale should not contain more than 5 to 8 per cent of impurities. A bushel of unhulled seed should weigh 25 pounds, which is considered the standard weight of a bushel.

Lespedeza seed, unlike that of many legumes, loses its viability in a relatively short time. Seeds that have been kept in storage for two years will germinate so poorly as to be almost worthless. The viability of seed that has been held over for only one season decreases materially, and when it is used the quantity sown per acre should be increased in accordance with the decreased germination. Many poor stands have resulted from seed being carried over for a year or two before being planted. At least 70 per cent of good lespedeza seed should germinate.

In view of the fact that lespedeza seed commonly contains an excess of impurities and germinates poorly, it is recommended that samples be submitted to either the State agricultural experiment station or one of the seed laboratories of the United States Department of Agriculture for analysis before purchasing.¹

PREPARATION OF THE SEED BED.

While lespedeza will grow year after year on hard, compact, uncultivated soil, it will respond in a marked degree to cultivation. At Arlington Farm, Va., in 1916 a crop 12 to 14 inches high was obtained on land that was well prepared, while the plants on adjacent plats that had received no cultivation grew only 5 to 6 inches high.

When lespedeza is to be sown on winter grain it is important that the soil be either plowed or disked and well pulverized before the grain is seeded. This will not only benefit the grain but will provide an excellent seed bed for the lespedeza. However, if oats should be seeded on lespedeza sod where a volunteer stand of lespedeza is expected, the land should be thoroughly disked only, as plowing will cover much of the seed too deep to germinate. Volunteer stands should not be depended upon when grain or cotton, or both, precede lespedeza, as a stand under such circumstances is

¹ Samples of seed may be submitted for a germination test to the Seed Laboratory, United States Department of Agriculture, Washington, D. C., or to the Branch Seed-Testing Station, Agricultural Experiment Station, Baton Rouge, La., which is maintained in cooperation with this Department.

unlikely. In a rotation comprising these crops the land should be plowed and pulverized before seeding the oats and a bushel of lespedeza seed to the acre sown the following spring.

Where the ground is too hard to disk, a method of preparing the seed bed recommended by the Tennessee Agricultural Experiment Station has given good results when grain is planted on lespedeza sod where a volunteer crop is expected after the grain is harvested. This method consists of breaking a furrow with a subsoil plow every 3 or 4 feet and disking the field at right angles to these furrows.

SEEDING.

Lespedeza should be sown during the latter part of February or the first part of March in the southern portion of the Gulf States and correspondingly later farther north, as the plants are very susceptible to frost injury. The seed is usually broadcasted either by hand or with a rotary seeder. Excellent results have been obtained in St. Mary's Parish, La., by using a disk drill. A more even distribution of the seed is obtained by sowing in this manner, but care should be exercised to see that the seed is not covered too deep. It is also necessary to wait until the ground is in a tillable condition, but the grain will not be injured by the disks of the drill when they are run at right angles to the rows of grain.

Some farmers broadcast the seed on the grain without loosening the surface soil and depend upon weather conditions to bury the seed. This method has not been as uniformly successful as where the field has been harrowed either before or after seeding, or both. When not harrowed, the seed will drift more or less, and much of it will lodge in low places, and especially in the rows of grain. Going over the grain once or twice with a harrow in which the teeth slant backward will not injure the grain, covers the lespedeza seed lightly, and provides a good condition for the young plants to become established.

When a hay crop is desired the first year at least 1 bushel (25 pounds) of seed should be sown to the acre. It is poor farm practice to sow less seed and to depend upon a scattering stand to reseed the field for a volunteer crop the second year. That means a light hay crop the first year and gives weeds an excellent opportunity to grow.

Most pastures throughout the South have been seeded with lespedeza through natural agencies. Where this is not the case a fair stand may be obtained by broadcasting 8 to 10 pounds of seed per acre over the top of the sod, but with better results if the sod is first harrowed. When the supply of seed to be sown is limited it is best to sow only the higher places in the pasture. The seed produced by these plants will be carried to the other portions of the field by water,

wind, and live stock, as the plants usually will produce an abundance of seed in spite of pasturing. A scattering stand may also be obtained by feeding in the pasture hay that contains ripe seeds. Pastures have also been seeded by scattering manure from live stock fed on ripe lespedeza hay and also by permitting stock to graze alternately on lespedeza pastures and on the pastures which it is desired to seed to this crop.

INOCULATION.

Lespedeza, like other legumes, utilizes atmospheric nitrogen through the nodules on the roots. Artificial inoculation is seldom necessary, as most of the soils of the South are naturally inoculated, owing to the general distribution of this plant and to the several wild species which are widely distributed. As lespedeza seed is sown in the hull and the hulls undoubtedly carry some of the bacteria, inoculation is often provided in this manner. However, in localities where this plant is grown for the first time, it is well to provide inoculation. This may be done by obtaining soil from a field where lespedeza grows abundantly and mixing it pound for pound with the seed. If soil can not be obtained, cultures for inoculating 1 bushel of the seed may be obtained free of charge from the United States Department of Agriculture.

USES OF LESPEDEZA.

Until comparatively recent years lespedeza was used principally as a pasture crop, and it is now used for this purpose more extensively than any other legume in the South. It is the principal legume hay crop in certain sections, however, particularly on the alluvial soils of Louisiana, Mississippi, Alabama, Arkansas, and Tennessee, where yields of 1 to 3 tons per acre are commonly obtained. The hay is of excellent quality and commands a good price on the market. (Fig. 3.)

Lespedeza has a beneficial effect on succeeding crops. In sections where it will make sufficient growth to be cut for hay it is used as a regular farm crop, the seed being sown when the crop is desired, according to the particular rotation employed.

LESPEDEZA PASTURES.

The value of lespedeza as a grazing crop is well known, and it is considered the best summer legume pasture crop for poor soils which has thus far been introduced into the South. It will make some growth even on sandy and gravelly hillsides, as well as upon heavy clay soils. While it produces good forage on these types of soil, maximum growth is obtained only on fertile clay loams and alluvial soils well supplied with moisture. The natural spread of lespedeza

has caused it to become a constituent of practically every pasture in the region to which it is adapted. The carrying capacity of most of the tame pastures in the South has been increased at least 25 per cent by lespedeza. Its value depends upon its palatability, its high feeding value (which approaches alfalfa and the true clovers), its ability to thrive under various conditions, and its long growing period, from early summer until killed by frost. It will withstand very heavy grazing, but it should not be grazed too closely in the late summer if it is expected to produce sufficient seed to reseed the field. When once established in the pasture, with proper care a good growth of lespedeza may be obtained for an indefinite time.

Thus far, no cases of bloat in live stock have been recorded from pasturing on lespedeza. This is probably due to the fact that it con-



FIG. 3.—A day's baling of lespedeza hay at Jackson, Tenn.

tains considerably less moisture than alfalfa and the true clovers. Like other legumes it causes horses and mules to slobber at times. In the lower Mississippi Valley, where lespedeza makes its best growth, the fields may be pastured until the first part of June and still make a hay crop, or the hay may be cut during the latter part of July or first part of August and the aftermath grazed. In cutting the hay in midsummer care should be exercised not to cut the plants so closely to the ground that they will be killed.

The best summer pastures in the South are those which consist of lespedeza in combination with Bermuda grass on the heavier soils and with carpet grass on the sandy soils. The addition of lespedeza to either Bermuda grass or carpet grass greatly improves the quality of the forage. (Fig. 4.) With the further addition of bur clover, white clover, hairy vetch, black medic, or yellow hop clover—all

winter-growing plants—the pastures may be grazed the year around. Winter grazing is also provided in some sections by disking the Bermuda grass and lespedeza sod in October after the lespedeza has matured seed and then sowing grain on the pasture. The grain should be grazed closely or clipped in the late spring, so as to give the lespedeza an opportunity to become established as soon as possible. In poor or mixed pastures lespedeza usually holds its own with broom sedge and similar coarse grasses and unquestionably adds materially to the grazing. It occasionally happens that the lespedeza seed germinates unusually early on account of the favorable weather, and the young plants are then killed by late freezes. In pastures where this occurs lespedeza may be reseeded according to the methods previously described.



FIG. 4.—Live stock on a pasture of lespedeza, Bermuda grass, and native grasses at Iberia Live-Stock Experiment Farm, Jeanerette, La.

LESPEDEZA AS A SOIL-IMPROVING CROP.

No definite experiments have been conducted to determine the value of lespedeza as compared with other standard southern legumes as a soil-improving crop. That it does much to improve the nitrogen and humus content of the soil is without question, although in sections where the plants grow only 5 to 6 inches high this improvement is much less than in the case of a good crop of cowpeas or velvet beans. The value of lespedeza in enriching the soil has been well demonstrated not only on the alluvial soils in the Mississippi River Delta but also on the uplands. In many cases the yield of oats has been more than doubled by following either an oats-lespedeza or corn-oats-lespedeza rotation. Many farmers believe that the fertilizing value of the roots and stubble of lespedeza is practically the same as that of cowpeas. Not only is the yield of oats greater but the yields of lespedeza hay increase to a limited extent with succeeding crops.

When a 2-inch stubble is left in cutting lespedeza for hay, not more than 70 per cent of the total weight of the plants is removed from the field; the remaining 30 per cent consists of roots, stubble, and shattered leaves. On this basis a yield of 2 tons of hay would leave a residue of approximately 1,700 pounds to the acre. As the roots and stubble contain 1.6 per cent and the leaves 3.2 per cent of nitrogen, the residue would contain approximately 34 pounds of nitrogen, or the quantity present in 210 pounds of 16 per cent nitrate of soda. It is often stated that not more than two-thirds of the total nitrogen content of legumes is taken from the air, and at least this quantity is removed with the hay. It can not be stated what percentage of nitrogen in the residue was taken from the air or what percentage from the soil, but it is evident that much of the soil nitrogen taken up by the plants would have leached from the soil had it not been utilized in this manner, so that from this standpoint a large percentage of the nitrogen in the residue is gained by growing the crop. This theory is borne out by the increased yields of the crops planted on lespedeza stubble land, as this increase is undoubtedly more than would have been obtained from the addition of the humus only, and the increase from the residue is very apparent with such crops as cotton and corn not only in the increased growth of the plants but also in the color of the foliage.

LESPEDEZA IN MEADOW MIXTURES.

Bermuda grass and lespedeza.—Lepedeza is very generally a constituent of Bermuda grass meadows and is often cut for hay in such a mixture. The presence of the lespedeza in Bermuda grass is desirable, as it adds materially to the quality of the hay. (Fig. 5.) A meadow containing this mixture may persist for years, but weeds finally will reduce its value. The meadow may then be plowed and planted to grain and the following spring to lespedeza. If favorable weather prevails after the grain is harvested, a crop of lespedeza hay will be obtained. This procedure will reduce the stand of Bermuda grass the year the grain is harvested, but the grass will thicken during the summer and there will be a perfect stand of Bermuda grass the following year.

Redtop and lespedeza.—When two crops of hay are desired from the same field each year redtop and lespedeza form an excellent combination. Redtop should be sown in the fall on a well-prepared seed bed, either with or without a grain crop. The lespedeza should be sown the following February. The redtop may not make sufficient growth to produce a cutting of hay after oat harvest, but in the autumn a hay crop consisting of a mixture of redtop and lespedeza may be harvested. The following year the redtop will be ready to cut about the first of June, at which time the lespedeza is only 3 or 4

inches high. After this crop is harvested the lespedeza will make a dense and almost pure stand until cut for hay in September or October. As redtop is a perennial it will come again the following year, while the lespedeza will reseed itself provided the hay is not cut before some of the seed is matured. This mixture may be grown until the field becomes infested with broom sedge or other weeds, when it should be plowed and planted to another crop. A mixture of redtop and lespedeza succeeds best on bottom land where there is plenty of moisture and often where the soil is too wet for grain or cotton. The combination of redtop and lespedeza differs from Bermuda grass and



FIG. 5.—Lespedeza in mixture with grasses at Iberia Live-Stock Experiment Farm, Jeanerette, La.

lespedeza in that Bermuda grass and lespedeza make their maximum growth at the same time, whereas the redtop-lespedeza combination yields first a cutting of redtop and later in the season an almost pure crop of lespedeza. This combination, however, can be recommended only on rich lowlands with an abundance of moisture.

Johnson grass and lespedeza.—In a few sections of the South lespedeza is grown on Johnson grass sod. When this mixture is grown, two cuttings of Johnson grass can be made during the summer, in addition to a cutting of lespedeza. The Johnson grass should not be permitted to grow more than 28 to 30 inches high before being cut, but even this growth will check the lespedeza if the stand of grass is heavy. As a rule, the lespedeza does not make more than sufficient

growth to be harvested for seed, but in any event the lespedeza should be so handled that mature Johnson grass seed is not present in lespedeza seed if it is to be offered for sale. This mixture has not been very successful, and before planting on an extensive area it should be tried thoroughly on a small scale. It is recommended only for soils infested with Johnson grass.

LESPEDEZA IN ROTATIONS.

In recent years lespedeza has been utilized more and more extensively as a farm crop. As it is an annual which will usually reseed the land, and as it may be planted with a grain crop and yield a cutting of hay after the grain is harvested, it may be profitably employed in a number of rotations, answering the same purpose in the South that red clover does in the North.

While a rotation of oats and lespedeza is not to be recommended as a general practice, it is successfully employed in many parts of the Mississippi River Delta. The objectionable feature of this rotation is the lack of an intertilled crop, allowing the fields to become so infested with weeds that it is almost impossible to harvest a good grade of lespedeza hay.

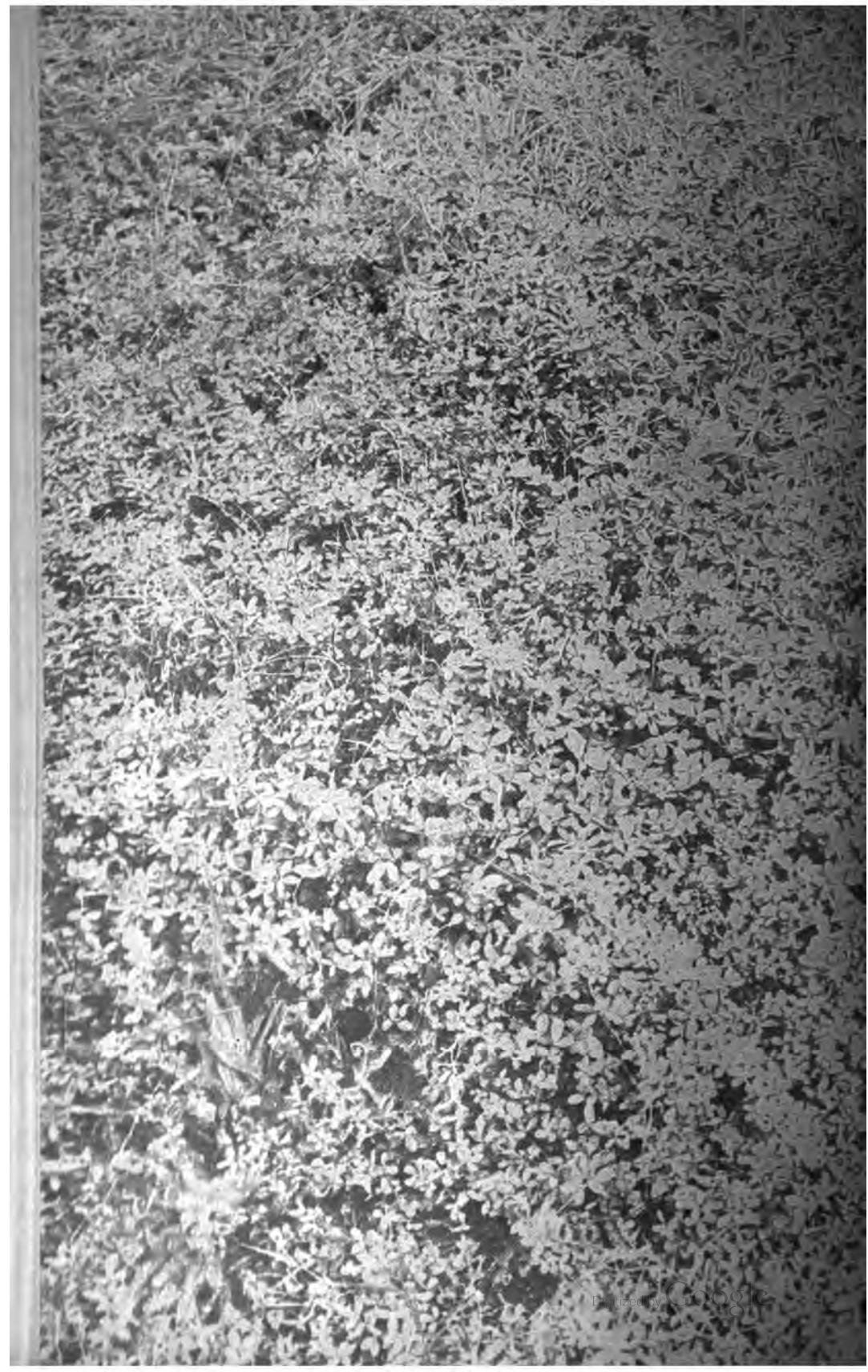
A 3-year rotation of corn, oats, and lespedeza is to be preferred to a rotation comprising only oats and lespedeza. In this rotation corn is harvested the first year, oats and lespedeza the second year, and lespedeza alone the third year. The lespedeza is often permitted to stand the fourth year, making a 4-year rotation. Cowpeas should be planted in the corn at the last cultivation. This rotation is practiced on many of the best-managed farms in Mississippi and Louisiana, and wherever it is used there is a marked increase in yields. In sections where it makes its maximum growth, lespedeza is comparable to cowpeas as a soil-improving crop.

This rotation also has the advantage over the oats-lespedeza rotation that an intertilled crop is used, which serves to check the growth of weeds. Soil erosion is also checked, because the fields are covered with oats one year and lespedeza stubble two years. This rotation also permits the farming of much more land than with corn and cotton alone. The additional work of harvesting the oats is quickly performed, and the extra work of harvesting the lespedeza comes at a time when it does not seriously interfere with other work, as it may be harvested at any time during September or early October without serious deterioration of the hay. Cotton may be added to this rotation after the lespedeza and before the land is again in corn. This will extend the rotation to four or five years, depending on whether the field is left in lespedeza one or two years.

SEED CROP.

Much of the seed of lespedeza is harvested in Louisiana and Mississippi. The crop is cut before frost and must be handled while still green or when dew is on it to prevent shattering. It is the common practice to dry the cut lespedeza in very small piles. Self-bunching attachments are sometimes used on mowing machines. When the crop is thoroughly dry it is hauled and stored or thrashed directly from the field. A tight wagon box will save much of the seed shattered while hauling.

Many growers save seed in a pan behind the cutter bar of a mowing machine. The cut lespedeza is raked over a grating of small rods over this pan by a man walking behind the machine. The lespedeza should be thoroughly ripe to be harvested in this manner. One great advantage is that the seed of crops too light to justify cutting, hauling, and thrashing may be saved by this method. Seed thus gathered is all right for home use, but it should be run through a fanning mill if it is to be sold on the market.



FARMERS' BULLETIN 1144
UNITED STATES DEPARTMENT OF AGRICULTURE

COOPERATIVE MARKETING



THE importance of farmers' cooperative organizations as agencies for improving marketing methods is gaining rapid recognition at the present time. The existence of at least 14,000 farmers' buying and selling associations in the United States shows clearly that American farmers appreciate the value of organized effort in effecting savings and improving service in the marketing of their products.

This bulletin gives suggestions for organizing cooperative marketing associations.

Contribution from the Bureau of Markets
GEORGE LIVINGSTON, Chief

Washington, D. C.

September, 1920

COOPERATIVE MARKETING.

O. B. JESNESS,
Specialist in Cooperative Organization.

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THE importance of farmers' cooperative organizations as agencies for improving marketing methods is gaining rapid recognition at the present time. The existence of at least 14,000 farmers' buying and selling associations in the United States shows clearly that American farmers appreciate the value of organized effort in effecting savings and improving service in the marketing of their products.

PURPOSE AND POSSIBILITIES OF COOPERATIVE MARKETING.

The faith which has been developed on the part of the American farmer in cooperation as a remedy for marketing difficulties has resulted from a realization of the need for united effort in solving common problems. The individual producer is unable to undertake many of the endeavors which are of vital importance to better and more economical marketing, but proper organization is supplying many communities with the means for carrying out work of this kind.

STANDARDIZATION OF PRODUCTS.

Standardization of the products grown in a community requires a common understanding and concerted action by the farmers of that community. By effective cooperation the farmers in a community producing potatoes for shipment can select a certain variety upon which to specialize. Standardization, however, is being carried further than this in many localities. The farmers not only have

agreed on varieties and kinds of products but have formed cooperative marketing associations to handle these products, with the result that they are placed upon the market after careful inspection and grading, so that they are of uniform quality and condition.

The farmer is frequently criticized for lack of attention to the uniformity and quality of his products. As an individual he is powerless to remedy this weakness. A multitude of other duties require his attention; he does not have an opportunity to become intimately acquainted with the demands of the trade; and his production is too limited to attract much attention, even though he uses a great deal of care in the handling and preparation for market of his products.

Cooperation has been of service in this way in the case of a group of cooperative cheese factories in Tillamook County, Oregon, which are united in an organization, having for one of its functions the standardization of the output of the factories belonging to it. The results achieved by potato growers on the Eastern Shore of Virginia, and by fruit growers in California and other sections indicate the possibilities of standardization by cooperative organization.

COMMUNITY PACKING.

Community packing is another important feature of many cooperative marketing associations handling certain products, such as fruits and vegetables. Community packing in charge of competent and disinterested men makes it possible to secure uniformity in grading and packing of the products of the members. Attractive labeling of the packages is an added feature in many instances.

Some of the larger cooperative marketing associations advertise the products of the members. Thus the California Fruit Growers' Exchange is able to advertise citrus fruits on a national scale at a comparatively small cost for each box of fruit handled. Advertising of anything except carefully graded products of uniform quality, of course, would not show much in the way of results. Special trade names and trade-marked brands in use by many growers' marketing organizations have become widely known and facilitate the sale of the products handled.

CROP AND MARKET INFORMATION.

Intelligent marketing is impossible without information concerning crop and market conditions. The average producer, however, lacks both the facilities and the time needed to obtain the most complete and reliable information of this nature. On that account he is placed at a disadvantage in marketing his products individually because the persons with whom he deals usually have more complete

COOPERATIVE MARKETING ORGANIZATIONS

Can Assist

in

Standardization

Improving Grading and Packing

Obtaining and Using Market Information

Developing Old Markets

Finding New Markets

Effecting Savings

Improving Service

Advertising

Buying Needed Supplies

information than he has. A cooperative marketing association controlling the products of a number of growers can employ experienced marketing men to obtain the necessary information and to sell the products to the best advantage.

BUILDING UP OUTLETS.

A cooperative organization handling the products of many growers is in a better position to establish and maintain outlets for these products than are the individual growers. An apple grower may produce his fruit with the greatest of care, but when it comes to marketing, his limited output does not command the attention which is given the larger volume handled by cooperative organizations. Well-established cooperative marketing enterprises have built up marketing connections and outlets which enable them to market their products advantageously.

PURCHASING SUPPLIES COOPERATIVELY.

Cooperative marketing associations frequently purchase supplies needed by their members. Many of the farmers' elevator companies not only handle grain but purchase for their patrons coal, lumber, twine, brick, flour, feed, oils, and other supplies. Fruit and vegetable marketing organizations in many instances buy cooperatively such supplies as fertilizers, spray materials, and packages. Marketing associations thus not only assist the farmers in disposing of their products, but are also of service in buying farm supplies which are needed by them.

WHEN SHOULD A COOPERATIVE MARKETING ORGANIZATION BE FORMED?

Cooperation is a remedy for many marketing difficulties, but it is a mistake to regard it as a cure for all ills. Like any other remedy, cooperative marketing should be used only in certain cases. Careful attention should be given to the local situation in a community where the formation of an association is under consideration, because local conditions have much to do with the chances which a cooperative organization has to succeed.

NECESSITY FOR ORGANIZATION.

The statement has been made and often repeated that a cooperative organization will not succeed unless it springs from necessity. The organization which is founded on dire need certainly has the best opportunity to succeed, and an organization for which there is no well-defined need is not likely to last very long. Farmers who are satisfied with the results secured without an organization do not

NECESSITY

Is .

**A Good Foundation
For a Cooperative Organization**

IF

**The Farmers in Your Community Feel a Need
For an Organization**

**They Will
Be Interested in It
Will Unite with It
Will Support It**

A NEED

**For a Cooperative Marketing Organization
May Be the Result of
A Lack of Marketing Facilities**

or

Unsatisfactory Marketing Facilities

DOES

**Your Community
Need
An Organization?**

feel a real need for an association, and their support of it will probably not be active. Necessity for organization may arise from the lack of marketing facilities or from dissatisfaction with existing agencies.

Some organizations are brought into being as a result of an enthusiasm created by appeals to prejudice and by misconception. Such a foundation is not nearly so secure as one which is created by a well-recognized need for an organization. Successful cooperative marketing ventures usually come from a small beginning and are the result of gradual and permanent growth.

ATTITUDE TOWARD ORGANIZATION.

The characteristics and make-up of the local population should be considered in the formation of a cooperative marketing association. The farmers in some communities look upon cooperative activities with favor, and are good cooperators; in other communities they lack faith in this remedy. Questions of race and nationality are not without effect and deserve careful consideration in planning for a cooperative organization.

PRODUCTS AVAILABLE.

Particular attention should be given to the kinds of products available for a marketing organization. A community which produces a considerable quantity of one product or a few products offers better opportunities for cooperative marketing than one which raises small amounts of a large number of widely different products. An organization handling one of the principal products of the community is better situated than one to which the handling of odds and ends is delegated.

ESSENTIALS FOR SUCCESS.

Cooperative marketing produces results, not by means of any magical power, but by the application of united effort and good business to common problems. This fact points to the importance of observing carefully the requirements for success.

SUFFICIENT BUSINESS.

The need for having a sufficient volume of business to make the economical operation of an organization possible would seem to be so evident that no special mention of this point would be required. Many marketing associations, however, have been undertaken where this essential was lacking. Sometimes this has been brought about through the efforts of promoters who were more interested in organiz-

SUCCESS
in
COOPERATIVE MARKETING
Depends Upon
Obtaining
A SUFFICIENT VOLUME OF BUSINESS
Observing
COOPERATIVE PRINCIPLES
Employing
CAPABLE MANAGEMENT
Following
UP-TO-DATE BUSINESS METHODS
Having
LOYAL MEMBERS

ing the association than in its chances for permanent success. Thus, some communities have been encouraged to establish a cooperative creamery by persons interested in selling equipment, when the number of cows in the territory tributary to the creamery was entirely too small to support such an enterprise. It is not sufficient to find out the amount of products grown in the locality where organization is contemplated; the volume of business available is the important point.

COOPERATIVE PRINCIPLES.

Cooperative principles must be adhered to in the organization and operation of farmers' marketing associations. The farmers in a community can not be expected to have a vital interest in a marketing organization which is operated for the profit of and controlled by a few individuals. The term "cooperative" is often used very loosely, with the result that many persons do not have a well-defined idea of what a cooperative organization really is. The ordinary noncooperative business corporation is operated for the profit of the persons who are financially interested in it. Distribution of profits is made in accordance with money invested, and the voting power is regulated in the same manner. In a cooperative marketing organization each member usually has only one vote, so that one or a few members will not control its operations. It is conducted to render service and to effect savings for the members, and not to earn profits for distribution as dividends on money invested. A fair rate of interest is granted to the capital invested by the members and the balance of any surplus to be distributed is divided in accordance with patronage; that is, the amount of business transacted with the organization. The membership of a cooperative association is open to producers desiring to avail themselves of its facilities, and safeguards are created to prevent the ownership and control of the enterprise from falling into the hands of a few.

Many farmers' organizations have been organized on the noncooperative plan. That the importance of the cooperative plan is now becoming generally recognized is evidenced by the fact that many noncooperative organizations are reorganizing and adopting cooperative principles. This is well illustrated by farmers' grain elevator companies, a large proportion of which have been organized along noncooperative lines, but many of which are now reorganizing and changing to the cooperative plan.

MANAGEMENT AND BUSINESS METHODS.

Able management is one of the most important requirements for success. Many organizations have had disastrous experiences with poor administration. The directors of a cooperative marketing asso-

THE GENERAL BUSINESS CORPORATION

Is operated for profit.

Grants each share a vote.

Places no limit on numbers of shares an individual may own.

Distributes profits as dividends on capital stock.

THE COOPERATIVE ORGANIZATION

Is operated to effect savings.

Allows each member only one vote.

Usually limits the financial interest any one member may have in it.

Restricts return on invested capital to a fair rate of interest.

Divides any further surplus to be distributed in accordance with patronage.

ciation should be broad-minded men who have the interests of the organization at heart. The business manager must be capable and be fitted for the position. Proper business methods go hand in hand with capable business management, and their importance must not be overlooked. Accurate accounting records are essential in order that complete information regarding the condition of the business may be available at all times. Frequent audits of the accounts of every cooperative organization by competent persons are of vital importance.

MEMBERSHIP LOYALTY.

A cooperative enterprise is directly dependent for its success upon the loyalty of the members and their interest in the organization. Lack of loyalty and interest on the part of the members has resulted in the downfall of many cooperative associations. Organizations founded upon a real desire of the members are less likely to suffer from lack of allegiance than those which have for their basis misconceptions and prejudice.

MEMBERSHIP CONTRACTS.

Contracts between the members and the organization whereby they agree to market certain products through it are vitally important in many instances, and especially in the case of associations engaged in the handling of perishable products. Specific agreements of this kind make it possible for the organization to plan intelligently for the handling of the business, because its management knows what products it will be called upon to market. Interests with which a cooperative marketing organization is competing sometimes offer temptations to the members in the form of higher prices for the purpose of breaking up the association and thereby eliminating this competition. Contracts which keep the members from yielding to temptations of this nature help the organization to survive these attacks.

The Michigan Potato Growers' Exchange, which was formed in 1918, has definite agreements with its members governing the sale of their potatoes. The California Fruit Growers' Exchange follows the same plan in its operations. Many other successful cooperative marketing organizations have demonstrated the value of members' contracts.

CONTRACTS PROTECT LOYAL MEMBERS.

Agreements binding the members to sell their products through the association in reality furnish a protection for the loyal members against the weakness of the other members whose allegiance is of less enduring quality. Some growers hesitate to sign contracts be-

CONTRACTS
Are Used
By
Many Cooperative Organizations
to
HOLD
Members Together
INSURE
Volume of Business
PERMIT
Management to Plan Intelligently
PROTECT
The Organization

cause they fail to realize that these agreements are for the best interests of their own organization, and, consequently, for their own benefit. A member who has confidence in his organization and intends to be loyal to it should have no real objection to placing himself on record by signing a contract which binds him to market certain products through the organization. A grower who lacks this confidence will not be a strong supporter of the enterprise, and one who intends to be disloyal to his organization is a dangerous enemy.

POOLING SALES.

The pooling of products sold through cooperative organizations is an important feature. By pooling is meant averaging the returns received for products sold during a certain period, or for certain shipments, so that each grower having products of the same grade receives the same price. This method of operation protects the individual member from loss because of unfavorable market conditions of a temporary nature. The following instance shows how failure to adopt a pooling system may result in an injustice to some members. A potato association shipped out two cars of potatoes on the same day. One car found a ready market, while the other one was sold at a considerably lower price, with the result that the growers having potatoes in the second car received less than the others through no fault of their own. Dissatisfaction naturally arose, and the manager experienced a great deal of difficulty in explaining the matter to the satisfaction of the growers. The success of a pooling system is dependent upon the observance of uniform and effective grading of the products.

Some farmers' marketing organizations, especially grain elevator companies, purchase the members' products outright. Conditions and practices in grain marketing make such a plan feasible, but organizations handling other products usually find it to their advantage to pool shipments and await returns before making payments to the growers. This method relieves the association of speculative risks, the avoidance of which is highly desirable. Cooperative creameries, which prorate to the patrons monthly, in accordance with the amount of butterfat each has delivered the preceding month, the returns received for products sold less operating expenses, are good examples of pooling.

The length of the pooling periods varies with the products handled and the local conditions. Thus there are carlot, daily, weekly, semi-monthly, monthly, and seasonal pools.

LOYALTY

On the part of the members is essential for the success of an organization.

Disloyalty has caused the failure of more than one cooperative organization.

A sure way for the members of an organization to destroy the enterprise is to withhold their support from it.

Lack of loyalty is a weakness which can be remedied only by the members themselves.

A cooperative marketing organization can not produce results unless it is used.

USE YOUR ORGANIZATION

BUT

DO NOT ABUSE IT.

FORMS OF ORGANIZATION.

Farmers' cooperative marketing associations may be grouped according to their form of organization into two general classes, one including those formed with capital stock; the other, those formed on the nonstock plan. Membership in organizations belonging to the former class is represented by the ownership of one or more shares of stock, while in the latter, the members pay a membership fee and receive a membership certificate.

CAPITAL STOCK FORM.

The capital-stock form has been adopted by many farmers' marketing associations. It is the form commonly employed by farmers' elevator companies, and also for the most part by cooperative creameries. The capital-stock form is better known on account of the fact that most noncooperative business corporations are organized with capital stock. State legislation has also been a factor in encouraging the use of the capital-stock plan, as more States have cooperative laws providing for the incorporation of cooperative associations with capital stock than have cooperative laws making provisions for nonstock organizations.

While the capital-stock form is the most suitable for certain lines of cooperative business, it has some disadvantages. It is frequently difficult to restrict the transfer of shares of stock, so that it may be possible for persons antagonistic to the organization to gain membership through the purchase of stock. While cooperative organizations with capital stock allow only one vote to each member, and not a vote for each share, control over the organization may still fall into the hands of a few persons as a result of all the capital stock being bought up by them. There is also present a temptation to change the organization from a cooperative to a profit-making enterprise, especially if the control passes into the hands of persons who are not patrons.

NONSTOCK FORM.

While the nonstock form has not been so widely known as the one with capital stock, it is gaining in popularity with lines of business for which it is adapted. Live-stock shipping associations for the most part are formed without capital stock. Many fruit and vegetable associations, milk producers' organizations, egg circles, and other cooperative organizations have adopted the nonstock form of organization. Among the larger cooperative enterprises which have found the nonstock plan suitable may be mentioned the Michigan Potato Growers' Exchange, the Florida Citrus Exchange, the California Fruit Growers' Exchange, and the New England Milk Producers' Association.

The make-up of the membership of a nonstock organization is controlled more easily than in the case of organizations with capital stock, because membership certificates usually are not transferable. A nonstock organization operated on the nonprofit plan is less likely to depart from the cooperative plan than a capital-stock association.

FINANCING.

Every organization should plan its financing very carefully in order that the capital requirements may be taken care of fully. Cooperative associations have frequently been hampered in their operations because of a lack of adequate financing.

PERMANENT CAPITAL.

Capital which is to be used for providing buildings and other equipment is obtained from membership fees, cash advances by the members, or the sale of shares of capital stock. While it is true that some successful organizations have provided such equipment on borrowed capital, such a plan is not adapted to general use. If the growers are ready for an organization they usually are prepared to furnish all, or at least a large proportion of the needed capital.

EMERGENCY CAPITAL.

Many marketing organizations require a certain amount of capital for short periods. If the sale of shares of stock or the payment of membership fees does not supply all the money required for use in this way it may be borrowed from the members, from banks, or other outside sources. Individual promissory notes of the members given to the association in proportion to the amount of business each expects to transact through the organization may be employed by the association as collateral security in obtaining loans for this purpose. Thus the members of a potato-marketing association may be required to give notes varying in amounts in accordance with the acreage of potatoes grown by each. The members of some organizations have signed joint notes, which have been used in borrowing money. A joint note, however, should be avoided, because responsible signers may be required to pay more than their proportionate share if collections from some of the others are impossible. The practice of obtaining loans with the aid of the personal credit of the directors is unfair to the directors, because each member shares in the benefits and should carry his part of the burden.

HOW TO ORGANIZE.

The organization of a cooperative association should be worked out step by step in accordance with a definite plan in order that no important feature may be overlooked.

PRELIMINARY SURVEY.

When the formation of a cooperative marketing association comes up for consideration, it is advisable to make a preliminary survey of the local situation in order to find out whether local conditions are ripe for cooperative work. In view of the fact that organizations which are founded on necessity have the best chances for success, this survey should ascertain the need for an organization. The attitude of the farmers toward the proposed undertaking should be learned, and information should be obtained regarding the amount of business available. Some attention should be given to the existing agencies which the organization intends to replace or supplement, in order to note whether the service which they are rendering is satisfactory.

AROUSING INTEREST.

If the survey of the situation indicates that conditions are favorable, the leaders in the movement should take steps to arouse interest among the farmers and to arrange meetings at which the proposition may be discussed. Care must be observed in this work to avoid making impossible claims in favor of the venture, or stirring up ungrounded suspicion of or prejudice against existing methods. Not only should the advantages of organization be pointed out, but every effort should be made to acquaint those interested with the responsibilities of membership in such an association in order that they may be fully awake to the necessity of unfailing loyalty to it.

COMMITTEES.

The selection of committees for various lines of work is highly desirable, as this places the responsibility for results on certain persons, and distributes the work properly among a number of individuals. One committee may make a study of the local situation and develop a plan of organization suited to the needs of the locality. Another committee can be of service in deciding upon and carrying out plans for arousing interest in the movement. After an organization has been decided upon, a committee on by-laws should be designated, and, also, a membership committee to obtain as large a membership as possible. Other committees may be designated to take care of special lines of work requiring attention.

SECURING INFORMATION.

Farmers undertaking the formation of a cooperative marketing association find it helpful to obtain all information possible concerning other organizations of a similar nature. There may be such organizations at neighboring points, and a committee can easily arrange to visit them.

THE FARMERS OF A COMMUNITY
Should be interested in an organization
Before
Its formation is undertaken.

AROUSE INTEREST
By
Holding meetings
Circulating printed information
Selecting a committee to canvass the community.

DISCUSS
The proposition thoroughly.

DO NOT
Claim impossible results for the venture.

EMPHASIZE
The need for an effective organization and the
importance of united support.

Bulletins relating to cooperative marketing published by the United States Department of Agriculture, State agricultural colleges and State departments, articles in farm papers, and well-known books on cooperation will be found helpful. Personal assistance from the United States Department of Agriculture, State agricultural colleges, and State departments of agriculture frequently can be secured in organizing an association, and should be sought whenever such assistance seems necessary for the perfection of an effective organization.

CONSIDERING PLANS.

After the farmers have had opportunity to give careful thought to the proposition a meeting may be called for the purpose of arriving at a final decision regarding the organization. If a definite plan and a set of by-laws have been prepared, they may be taken up for consideration at this meeting, in case organization is decided upon, otherwise another meeting should be held as soon as these have been prepared. The plan and the by-laws should be worked out very carefully in order that the results may suit local requirements. A full and free discussion of all important points is desirable in order that there may be no misunderstanding of any features of the plan.

BY-LAWS.¹

The by-laws of a cooperative organization should cover more than a few well-known rules. They should outline the working plan of the organization. Too frequently insufficient attention is given to the preparation of the by-laws because their importance is not appreciated fully.

CONTENTS OF BY-LAWS.

Among the points which the by-laws should cover may be mentioned a statement of the objects of the organization; an outline of membership requirements; provisions relating to meetings, quorum, and the fiscal year; election of directors and officers, their powers, duties, and removal; the business manager, his powers and duties; methods of financing the organization; the grading, inspection, and handling of products; members' contracts; the rights, duties, and responsibilities of members; the method of meeting the expenses of operation; the manner of distributing savings; the auditing of the books; the procedure to be followed in amending the by-laws; and any other points of importance.

¹ A suggested form of by-laws may be obtained from the Bureau of Markets, U. S. Department of Agriculture, Washington, D. C.

BY-LAWS

Are Very Important

DRAFT

Them Very Carefully

ADAPT

Them to Local Conditions

DISCUSS

Them Fully, Section by Section

ADOPT

Them by a Membership Vote

ADOPTING THE BY-LAWS.

When the by-laws are up for consideration it is advisable to take them up by sections so that a clear idea of the purpose and contents of each section may be obtained. Each section may be voted on separately, and after the entire by-laws have been taken up in this manner a vote may be taken on the adoption of the by-laws as a whole.

Because of the part played by the by-laws in outlining the plan of organization, they are usually adopted at a meeting of the prospective members before the association has been organized. It is, of course, necessary to adopt the by-laws again after incorporating, but when they have been passed on by the prospective members in the manner suggested above, they may be adopted as the by-laws of the association by a vote of the incorporators or the members in the same form as when they were first adopted, unless some change is necessary to make them harmonize with law.

INCORPORATION.

Cooperative marketing organizations may be voluntary unincorporated associations, or they may be incorporated. Most business organizations are incorporated, and this is advisable in the case of cooperative marketing associations. Incorporation gives the organization a definite legal standing, and usually limits the liability of the members. An unincorporated association does not have so desirable a legal status as that of an incorporated organization, is unable to bring suit except in the names of the individual members, and the liability of the members is not limited.

HOW EFFECTED.

Incorporation is provided for by State law. All States have some form of incorporation laws, but not all States have cooperative laws; that is, special laws for the incorporation of cooperative associations. In States where there is no cooperative law incorporation must be effected under the laws designed for the incorporation of ordinary business corporations. Unfortunately, however, such laws usually do not provide for the cooperative method of operation.

More than two-thirds of the States have special laws for the incorporation of cooperative associations,¹ and the number is gradually increasing. Some of these laws provide for organizations

¹ Among States having cooperative laws may be mentioned: Alabama, California, Colorado, Connecticut, Florida, Illinois, Indiana, Iowa, Kansas, Louisiana, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, Nevada, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Vermont, Virginia, Washington, Wisconsin, Wyoming.

formed with capital stock, while others provide for the nonstock form. In the several States where provisions have been made for the incorporation of both capital stock and nonstock associations the law best suited to the needs of the organization should be selected as the one under which to incorporate.

The filing of articles of association, or articles of incorporation, is one of the first steps in incorporation. The contents of the articles of incorporation should harmonize with the requirements of State laws. It is advisable to include in these articles the important points to be covered in the by-laws. Competent legal assistance is of value in the preparation of the articles of incorporation. If a set of by-laws has been passed upon, this will be helpful to the incorporators and their legal counsel in drawing up the articles.

When the articles of incorporation have been prepared they are signed and acknowledged by the persons acting as incorporators and are usually filed with some official or officials designated by the incorporation laws. An incorporation fee also must be paid. The exact procedure and the amount of the filing fees vary in the different States, consequently it is impossible to supply detailed information in a general statement.

INCORPORATORS.

In case a temporary board of directors is selected at the time organization is decided upon, the persons on this board may act as the incorporators of the organization, or a committee may be designated for this work. The number of incorporators required is fixed by the incorporation laws. In a few States the minimum number is greater than the usual number of directors, and in such case provision will have to be made accordingly. All possible information with reference to the incorporation laws of the State should be obtained as early as possible, as the provisions of the law should be clearly understood when the plan of organization is decided upon. Such information is of importance to the incorporators in carrying out their duties.

LEGAL ADVICE.

A competent attorney can be of considerable service in supplying necessary information and in assisting in the drawing up of the necessary papers. If possible, an attorney well acquainted with the principles of and legislation relating to cooperative organizations should be secured. Many competent attorneys have had no occasion to prepare plans for such enterprises, consequently care should be taken that the cooperative features of the plan may not be overlooked.

SELECTION AND QUALIFICATIONS OF THE MANAGEMENT.

Good management is such an important essential for success in cooperative marketing organizations that special thought should be given to the selection of properly qualified persons for this work. General supervision over the activities of an organization is placed in the hands of the board of directors, which in turn selects the business manager, who is in immediate charge of the work of the organization under its direction.

DIRECTORS AND OFFICERS.

The board of directors of an association is elected by the members from among their own number. The men selected for positions of this kind ought to understand the operation of the organization and be fully acquainted with its needs. The directors should have the best interests of the community at heart and possess the confidence of the members.

One plan which has gained considerable popularity among cooperative associations is that of having the directors hold office for three years, one-third of them being elected each year. This method tends to prevent any radical changes in policy which might result if an entirely new set of directors were selected every year. Recall of directors is made possible with many organizations, so that unsuitable directors may be removed without waiting for the expiration of their terms of office.

Attention may be given to the advisability of having the various sections of a community represented on the board of directors. The size of the board, however, should not be so large as to make it unwieldy. Usually five, seven, or nine directors constitute the board. If the number is large an executive committee made up of a smaller number may be designated by the board to carry out certain of its functions.

Unless the law under which the organization is incorporated provides that the members shall elect the officers, it is believed preferable to let the board of directors select them, as the latter plan is likely to result in a more smoothly working body. The officers, as a rule, are members of the board, although in some instances the position of secretary-treasurer may be filled by the appointment of a non-member in order to obtain the services of an outsider who has special qualifications for the place.

THE MANAGER

*is the
Keystone
of the Organization*

EMPLOY

A Competent Manager

SELECT

A Man with Proper Qualifications

PAY

A Salary Which Will Attract Ability

GIVE

Him Authority

SUPPORT

His Work

THE MANAGER.

The manager holds a very important position in a cooperative association, as he is in direct charge of its operations. The board of directors employ the manager, and in selecting him they should keep in mind the qualifications required to fit a man for this position. Relationship, friendship, or membership in the organization should have no place in deciding upon the manager, although, unfortunately, these factors are only too often among the main considerations.

The manager should be experienced in the marketing of the products to be handled. He must possess tact and good judgment, and be honest and above suspicion. Much depends upon his ability to meet the members and the trade with which the organization deals, and to retain their confidence.

Some associations allow questions of salary to play too large a part in hiring a manager. It is well to remember that the applicant who is willing to accept the place at the smallest salary often is not the cheapest in the long run. Mistakes in management may result in losses much larger than the difference between the salary of an inefficient manager and that of a capable one.

Broad powers should be given the manager by the board of directors, in order that he may have an opportunity to work out complete plans for the organization and put them into operation. Under the general supervision of the board of directors, the manager should have authority to employ and direct the necessary help. He should have charge of the grading, handling, and marketing of the products sold through the organization. A manager who has been selected because of fitness for the place can be granted freedom of action without danger. No other kind of manager should be employed by a cooperative organization.

BONDING.

The board of directors should require all officers and employees charged by the association with responsibility for the custody of any of its funds or property to give a bond for the protection of the organization. In view of the fact that the purpose of such bonds is to protect the organization, the cost of procuring them may be paid by the association.

DUTIES OF THE MEMBERS.

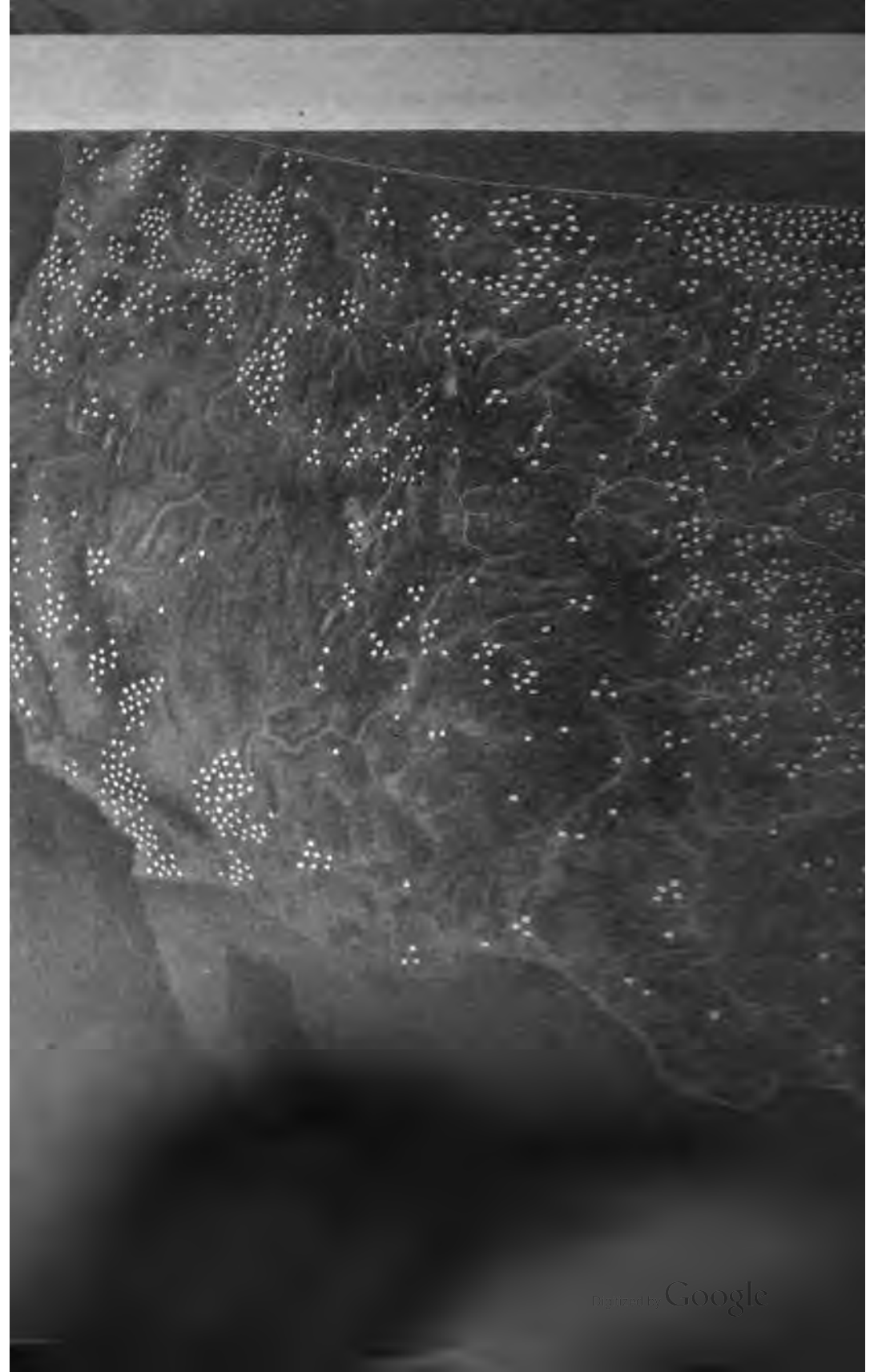
Observance by the members of their duty toward the organization is essential to the success of any cooperative venture. The members must never forget that the organization is theirs, and that they are an important part of it. If they fail to give their patronage to it and to lend it their moral support, the result will be failure.

Loyalty on the part of the members is the most important requirement for success. Producers who unite with an organization and then fail to support it have themselves to blame if the venture does not succeed. The member who neglects to market his products through an organization whenever it is to his temporary advantage to sell outside belongs to a class which has wrecked more than one cooperative undertaking. The producer who is willing to stay outside of the organization and reap the benefits without supporting it makes his neighbors carry his share of the load.

COOPERATIVE MARKETING AND EXISTING ORGANIZATIONS.

Many communities which take up for consideration cooperative marketing have an existing organization formed for some other purposes. This organization may be a farmers' club, or social or educational society. Some persons are strong advocates of the use of such associations for cooperative marketing purposes in place of organizing a special organization for this purpose. The fact must not be overlooked, however, that the machinery provided must be suited to the work in hand. Usually associations for productive or social purposes are not at all adapted to marketing activities. To call upon them to perform this work will hamper the activities for which they are designed and produce unsatisfactory results in marketing.

Organizations of the kind indicated, however, can and do serve a very useful purpose in connection with the formation of cooperative marketing associations, because the meetings of such associations furnish an excellent place for the discussion of plans. These organizations also serve to educate their members in organized effort, and this is a valuable preliminary step to cooperative marketing activities.



FARMERS' BULLETIN 1145
UNITED STATES DEPARTMENT OF AGRICULTURE

— Handling and — Transportation of CANTALOUPES



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FULLY 10 per cent of the cantaloupes produced in the Western States reach the consumer so green that they are practically worthless for food.

The carrying and keeping qualities are directly dependent upon the care exercised in harvesting and preparing for market.

Cantaloupes for long-distance shipment should be picked just before the full-slip state of maturity.

After picking, cantaloupes should be loaded as soon as possible into iced refrigerator cars for shipment.

Cantaloupes should preferably not be wrapped. They do not refrigerate so well in transit nor do they reach the consumer in as good condition as unwrapped cantaloupes.

Loading different styles of packages together obstructs air circulation and seriously retards refrigeration.

Floor racks are an efficient aid in the refrigeration of cantaloupe shipments. In cars equipped with floor racks and basket bunkers, salt may be effectively employed to hasten refrigeration.

The ability of refrigerator cars to cool cantaloupe shipments quickly and to maintain desirable temperatures in transit depends directly upon proper bunker and bulkhead construction and upon the quantity and quality of the insulating material used.

This bulletin is a revision of Markets Document 9, "More Care is Needed in Handling Western Cantaloupes," and Markets Document 10, "Loading and Transporting Western Cantaloupes."

Contribution from the Bureau of Markets.
GEORGE LIVINGSTON, Chief.

Washington, D. C.

May, 1921.

THE HANDLING AND TRANSPORTATION OF CANTALOUPEs.

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COMMERCIAL CANTALOUPEs TRAVEL LONG DISTANCES.

ABOUT four-fifths of the 21,402 cars of cantaloupes shipped in the United States in 1920 originated in the States of Colorado, New Mexico, Arizona, Nevada, and California. The larger part of these cantaloupes found their way to middle western and eastern markets—a journey requiring anywhere from 6 to 12 days. Those that were properly picked and carefully handled delighted the consumers with their rich color and delicious flavor. A large number, however, were picked so immature that even in distant markets consumers found them green and tasteless.

Green melons have a depressing effect on both demand and prices. If 1 per cent of the annual production of the Western States were picked and shipped unripe, buyers would purchase more than 40,000 crates of cantaloupes practically worthless for food. Instead of only 1 per cent, fully 10 per cent are so immature when placed upon the market that they are not palatable nor even of fair eating quality. It is little wonder that many householders are unwilling to buy fruit of such doubtful quality.

During three recent shipping seasons the Department of Agriculture conducted investigations¹ in the western producing sections and chief eastern consuming centers in order to determine the most satisfactory methods for handling cantaloupes for long-distance shipment. Several test trips were made. Some of the more important results of these investigations which may be of benefit to growers and shippers are presented in this bulletin. While the studies were

¹ The methods used in these investigations are outlined on page 23

confined to certain areas, the fundamental principles in regard to maturity at time of picking, careful packing, prompt shipment, and thorough refrigeration are directly applicable to the handling of cantaloupes wherever grown and to any shipments which are three days or longer in transit.

PICKING JUST BEFORE FULL SLIP INSURES BEST QUALITIES.

While it is necessary that cantaloupes be picked before they are entirely ripe in order to provide the essential keeping quality in transit, they may be picked at a stage of maturity that will afford good flavor as well as keeping quality. To insure the best eating quality when they reach consumers, cantaloupes should be picked just after they will slip cleanly from the stem; that is, at the full-slip stage of maturity. If properly handled and promptly loaded they will carry in satisfactory condition even to distant markets. Allowance must be made, however, for a certain amount of rough handling and for some delay in transit. As a general rule, therefore, cantaloupes should be picked just before they reach the full-slip stage. Such melons possess not only the desirable eating quality but also the necessary carrying quality.

If cantaloupes are to be in transit 10 days or more, it is advisable to pick them just before they reach the full-slip stage of maturity. This conclusion is based on inspections of comparative shipments of Pollock cantaloupes from the Imperial Valley and Turlock districts of California to New York City during the seasons of 1916 and 1917. Table 1 gives the average results of inspections of 29 shipments.

TABLE 1.—*Condition of cantaloupes in New York City, on unloading from refrigerator cars, and two days later, season of 1917, as shown by inspection.*

Condition of melons.	On unloading.			Two days later.		
	Picked full slip.	Picked just before full slip.	Picked commercially.	Picked full slip.	Picked just before full slip.	Picked commercially.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Too soft to be desirable.....	12.7	9.7	13.4	17.7	1.6	20.7
Too yellow, overripe.....	11.5	2.2	6.1	27.0	10.7	14.9
Decayed enough to spoil for food.....	.1	.	.3	3.1	1.1	5.1
Meat "cukie" or of tough immature texture.....	(1)	(1)	(1)	3.5	1.1	1.4
Meat too ripe to be desirable.....	(1)	(1)	(1)	.1	1.9	13.9

¹ Not recorded.

CAREFUL HANDLING PREVENTS BRUISING AND DECAY.

The carrying and keeping qualities of cantaloupes are directly dependent on the care exercised to prevent mechanical injuries in harvesting and preparation for shipment. The present commercial handling practices are unnecessarily rough and are responsible for a large

amount of decay and spoilage in transit and after arrival at market. These conclusions are based on inspections of comparative shipments of Pollock cantaloupes from the Imperial Valley and Turlock districts, Calif., to New York City during the seasons of 1916 and 1917. Table 2 gives the average results of 20 experimental shipments from Turlock, Calif.

TABLE 2.—*Deterioration found in 20 experimental shipments of carefully handled and commercially handled cantaloupes, on unloading from refrigerator cars in New York City, and two days later, season of 1917.*

Condition of melons.	On unloading.		Two days later.	
	Carefully handled.	Commercially handled.	Carefully handled.	Commercially handled.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Decayed enough to spoil for food.....	0.0	0.5	0.4	6.0
Molded enough to affect appearance.....	.5	2.4	3.5	9.2
Spoiled for food by bruising only.....	(1)	(1)	3.5	11.7

¹ Not recorded.

From the standpoint of minimizing bruising or other mechanical injury many faults in present handling practices may be corrected readily by reasonable attention to equipment and labor. The regulation lemon or orange picking bags made of fairly heavy canvas and equipped with shoulder straps are preferable to the burlap or grain sacks commonly used. Sacks without shoulder straps are constantly being raised and lowered and dragged over the ground by the pickers. A large percentage of commercially handled cantaloupes is bruised in this manner. Bags with shoulder straps leave the hands of the pickers free, and the openings at the bottoms permit the bags to be lowered into the crates and so lifted that the melons will roll out gently.

No cantaloupes should project above the upper edges of the field crates. If this precaution is neglected, the top crates when loaded on the field wagon rest on the projecting melons in the crates below, and serious bruising inevitably occurs.

When unloaded from field wagons, crates should be stacked with care to avoid dropping or other jarring. Cantaloupes from field crates should be graded or emptied carefully into packing bins without unnecessary throwing, dropping, or rolling. The lining of packing bins should be made of soft material, or, if made of boards, should be well padded to prevent bruising.

During the operation of packing, cantaloupes should be placed carefully in the crates and not dropped or tossed into place, as is frequently done. Injury caused by squeezing can be prevented if packers are careful not to force in oversized melons when finishing crates.

Cantaloupes should be packed so that the tops of the crates bulge slightly when cover slats are nailed on. If the tops bulge too much, the cantaloupes become squeezed and bruised, and spoilage results.

Packed crates require just as careful handling as do individual melons prior to packing. They should be stacked only on their sides, as the side bulge is usually much less than that of the top and there is thus less chance of injuring the cantaloupes. Wagons used for conveying packed crates to car-loading platforms should be equipped with springs to reduce injury from jarring.

The greatest care should be exercised in stacking packed crates, in stowing them in cars, and in loading them on and off wagons. It frequently happens, through accident or carelessness, that packed crates are thrown or dropped into position. It is hardly necessary to call attention to the serious injury and deterioration resulting from such carelessness. This applies with equal force to the handling which crates receive during unloading from cars and during distribution to wholesale, jobbing and retail stores.

PROMPT LOADING INTO REFRIGERATOR CARS REDUCES LOSSES.

The reduction of serious market losses from oversoft, overripe, and decayed cantaloupes is dependent to a large extent upon the prompt-



FIG. 1.—Immediate versus delayed loading of cantaloupes. Note the greater shrinkage in the crate on the right as compared with the crate on the left. The crate on the right was not placed under refrigeration until 24 hours after the melons were picked, while the crate on the left was loaded three hours after picking. This photograph was taken two days after they were unloaded at destination.

ness with which they are placed under refrigeration. After picking, cantaloupes should be hauled without delay from the field to the packing shed, where they should be kept in the shade until packed. They should be packed immediately, and while being hauled from the packing shed to the car-loading platform, should be covered with canvas or other light-colored cloth to protect them from the sun. As soon as possible after packing, cantaloupes should be loaded into iced refrigerator cars for shipment. The importance of this promptness is illustrated in figure 1.

The inspection data of experimental shipments of Pollock cantaloupes from the Imperial Valley to New York City during the seasons of 1916 and 1917 also strongly emphasize this factor. Table 3 gives

the average results of inspections of 13 shipments of comparative lots delayed one, four, and eight hours before loading during the season of 1917.

TABLE 3.—*Condition of cantaloupes held 1 hour, 4 hours, and 8 hours at shipping point before loading into refrigerator cars, on unloading in New York City, and two days later, season of 1917, as shown by inspection.*

Condition of melons.	On unloading.			Two days later.		
	1 hour.	4 hours.	8 hours.	1 hour.	4 hours.	8 hours.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Too soft to be desirable.....	8.4	16.7	27.0	30.6	34.7	43.2
Too yellow—overripe.....	8.4	13.3	15.0	20.9	21.5	26.3
Decayed enough to spoil for food.....			1.2	2.9	3.3	4.4

WRAPPING PROMOTES THE DEVELOPMENT OF MOLD.

Wrapped cantaloupes do not refrigerate so well in transit and do not reach consumers in as good condition as do unwrapped cantaloupes. These conclusions are based on inspections of comparative shipments of Pollock cantaloupes from the Imperial Valley, California, to New York City during the seasons of 1916 and 1917. Table 4 gives the average results of 13 shipments.

TABLE 4.—*Condition of 13 experimental shipments of wrapped and unwrapped cantaloupes in New York City, on unloading and two days later, season of 1917, as shown by inspection.*

Condition of melons.	On unloading.		Two days later.	
	Wrapped.	Unwrapped.	Wrapped.	Unwrapped.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Too soft to be desirable.....	17.7	15.3	28.8	34.0
Too yellow—overripe.....	8.7	4.6	17.7	2.7
Decayed enough to spoil for food.....	.5	.0	22.7	4.6
Molded enough to affect appearance.....	3.1	.2	42.4	2.7

Two days after cantaloupes involved in these studies were unloaded from refrigerator cars at the markets, the wrapped melons were slightly firmer than the unwrapped, because the wrappers retarded to some extent the evaporation of moisture. The difference, however, is so slight that it does not compensate for the increase in decay and mold which wrapping causes.

Free circulation of cold air around each crate and around each melon is essential to quick, effective refrigeration in transit. Wrapped cantaloupes cool more slowly than those not wrapped because the paper retards the free circulation of cold air and acts to some extent as an insulator, preventing the free transmission of heat from the melons.

Figure 2 presents the average of the top and bottom layer temperatures of two cars of similar construction, loaded similarly, with the exception that the melons in one were wrapped and those in the other were not wrapped. The differences shown are representative of the retardation of refrigeration which may be expected when cantaloupes are wrapped for shipment.

It is not advisable to wrap cantaloupes, even though it is impossible to load them immediately after packing. A comparison of

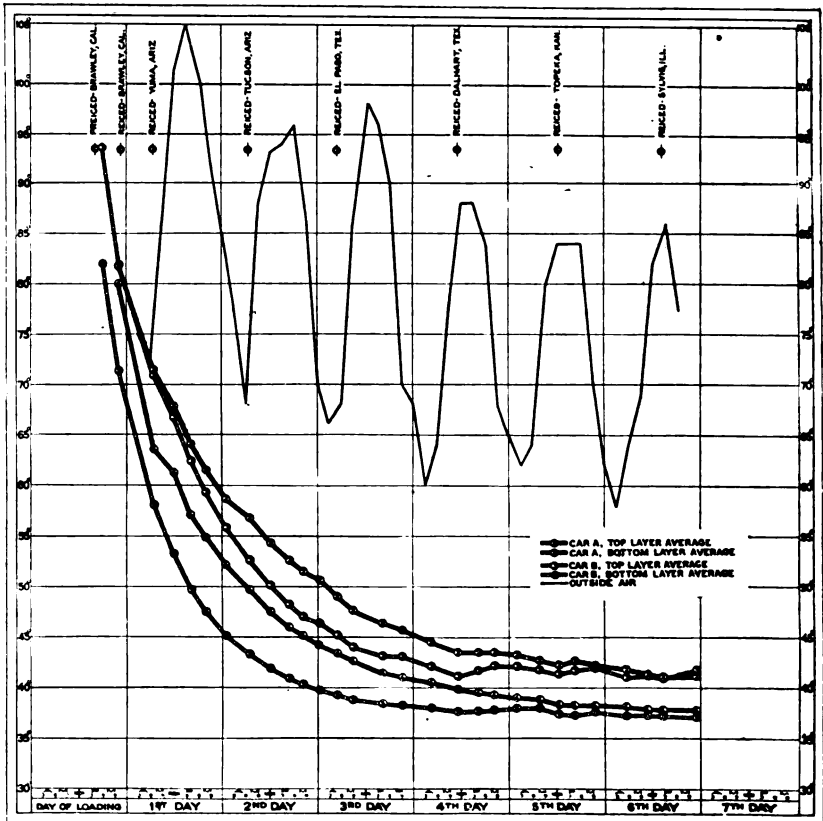


FIG. 2.—Diagram illustrating the effect of wrapping cantaloupes upon temperatures in transit. The melons in car A were wrapped; those in car B were not wrapped. These cars were in transit from Brawley, Calif., to Chicago, Ill., June 19 to 25, 1916.

the data in Tables 3 and 4 shows that two days after unloading from refrigerator cars the loss resulting from delay in loading is much less than the loss from wrapping. This loss would naturally occur in any wrapped cantaloupes, whether they were loaded for shipment immediately after packing or whether they were held in the open for a considerable time before loading, because the loss from wrapping occurs after the cantaloupes are unloaded from refrigerator cars at centers of consumption.

Most of the loss from wrapping occurs because of decay and mold which develop after cantaloupes are unloaded from refrigerator cars at centers of consumption. When, on summer days, crates of cold cantaloupes are removed from refrigerator cars, moisture from the atmosphere condenses on the surface of the melons. This moisture soon evaporates from unwrapped cantaloupes, but from wrapped cantaloupes the evaporation is hindered by the paper, which tends to retain the condensed moisture. This retained moisture acts as a medium favorable to the growth of organisms which cause the development of decay and mold, as illustrated in figure 3.

Aside from causing losses through decay and mold, the practice of wrapping is undesirable because it enables unscrupulous persons to cover and pack defective cantaloupes which, if not wrapped, would be thrown out. Both in producing sections and at centers



FIG. 3.—Wrapped versus not wrapped cantaloupes. Those on the left were wrapped, those on the right were not wrapped. This photograph illustrates their condition two days after unloading from a refrigerator car. Note the mold on those melons which were wrapped.

of consumption, inspectors and buyers find it more difficult to examine crates of wrapped melons.

MIXED LOADING OBSTRUCTS REFRIGERATION.

The method of loading employed and the care taken to secure a uniformly spaced load are factors of great importance in influencing the refrigeration of cantaloupes in transit which are under the direct control of the shipper. One of the greatest obstacles to rapid and uniform refrigeration is the common practice of mixing different styles of packages in the same load. The circulation of cold air from the ice bunkers through the load is necessarily slow even under the best conditions, and if open spaces between the rows of packages are not provided, the flow of cold air toward the center of the car is still further checked. Under these conditions the cold air

from the ice bunkers rises toward the ceiling of the car, and returns to the bunker without completing its normal circuit, and consequently refrigeration of the crates in the center of the car is retarded materially.

Although mixed loading is the most common cause of these air blockades, careless loading or shifting of packages will bring about the same unfavorable condition. Every effort should be made to load only one style of package in the same end of a car. If it should be necessary to load flats and standard crates together, the flats should be placed on top layers or in the stacks nearest the bracing.

The practice of opening either the front or rear ventilators of a refrigerator car during the first night the car is in transit has some adherents among cantaloupe shippers. Some of them think that cantaloupes arrive at market in a firmer condition and that fewer yellow melons develop when the ventilators are so opened. A few tests of the value of this practice have been made, but the results obtained are inconclusive. It can be definitely stated that refrigeration is not hastened by this practice; on the other hand, the admission of outside air during the night does not seem to raise the cantaloupe temperatures or retard refrigeration. An average of 400 or 500 additional pounds of ice is melted in each car when the ventilators are open.

TEMPERATURES VARY IN DIFFERENT PARTS OF THE SAME LOAD.

Figure 4 shows the temperatures secured in four cars of cantaloupes, which were included in a test trip from Brawley, Calif., in 1916. Two of these cars were loaded 7 crates wide and 3 high throughout. The other two were loaded 6 crates wide and 4 high, for a distance of 4 stacks from each bulkhead. The remainder of the load was 3 crates high.

The temperature records, which have been confirmed by later tests, show that cantaloupes 4 crates high can not be cooled satisfactorily in the ordinary refrigerator car. It will be noted that the average temperature of the top layer crates at the bulkhead in cars loaded 6 wide and 4 high is higher than the top layer temperature in the center of the cars loaded 7 wide and 3 high, and considerably higher than the top layer temperature at the bulkhead of these cars. The average temperature at the center of the cars loaded 6 crates wide was lower than the temperatures against the bulkhead, owing to the fact that the melons were only 3 crates high at this point. It corresponded almost exactly to the average top layer temperature at the center of the cars loaded 7 wide, and for that reason has not been included in the diagram.

Figures 5 to 10 illustrate graphically the temperatures in transit secured in cars of cantaloupes, when the cars vary in construction

and in the refrigeration methods employed. The six temperatures shown on each chart are those which are approximately representative of conditions throughout the whole load. They were secured in crates located in the top layer at the bulkhead, the bottom layer at the bulkhead, the top layer half way between the bulkhead and door frame, the bottom layer halfway between the bulkhead and door

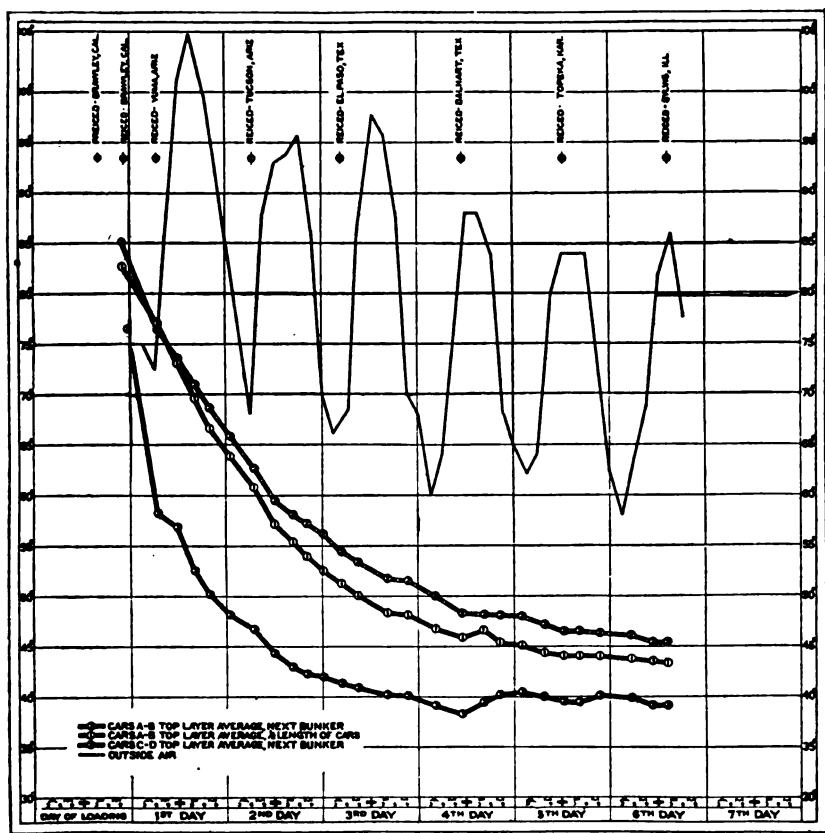


FIG. 4.—Diagram showing top layer temperatures at the bulkhead and adjacent to the bracing in cantaloupe shipments. Each curve represents the average of two cars. Cars A and B were loaded 7 crates wide and 3 crates high throughout; cars C and D were loaded 6 crates wide throughout and 4 crates high in the 4 stacks next to each bulkhead. These cars were in transit from Brawley, Calif., to Chicago, Ill., June 19 to 25, 1916.

frame, the top layer next to the bracing, and the bottom layer next to the bracing. It will be noted that the temperatures in these six positions vary considerably.

FLOOR RACKS ARE AN AID TO UNIFORM REFRIGERATION.

Slatted false floors, or floor racks, have proved to be a most effective aid to refrigeration, and have been included as part of the equipment of nearly all refrigerator cars constructed since 1916. As

permanently constructed, the floor racks are hinged to the car walls, and may be raised when the car is cleaned. The cross-slats are about 4 inches wide, and are sufficiently close together to permit trucking over the racks. The lengthwise stringers are 4 inches high, providing a clear 4-inch air space under the entire load.

Figure 5 presents graphically the temperatures in an ordinary refrigerator car, loaded 7 crates wide and 3 high, shipped from Brawley, Calif., to New York City in June, 1917. Figure 7 shows the temperatures in a car equipped with solid insulated bunker bulkheads and floor racks, shipped from Brawley, Calif., to New York City at the same time. It will be noted that refrigeration is more uniform in the car with floor racks and that cooling proceeds more rapidly. This fact is very noticeable in the temperatures of the top layer crates, especially the one located near the doorway. Other tests have demonstrated that the temperatures shown in these diagrams are representative of the conditions obtained in cars of these two types. The additional cooling obtained by the use of floor racks is an important factor in retarding ripening and deterioration. The reduction of the temperatures of the top layer is now the chief problem in transit refrigeration.

SUCCESSFUL INSULATION DEPENDS UPON CAR CONSTRUCTION.

The bunker and bulkhead construction of refrigerator cars has an important effect on the refrigeration obtained in transit. In the ordinary box bunker air circulation is obstructed by the mass of ice, and refrigeration of the shipment is retarded in consequence. To overcome this difficulty, it has been found desirable to attach heavy wire screens, or perforated metal sheets, to 2-inch vertical nailing strips, which are secured to the sides and ends of the bunker. This so-called "basket bunker" provides a clear 2-inch air space on all sides of the ice. The advantages of this space may be clearly seen.

A solid, insulated bunker bulkhead with 12 to 14 inch openings at the top and bottom has been found more effective than the open type of bulkhead, when used with the wire-basket bunker and floor racks. With a bulkhead of this type, the air must pass to the bottom of the bunker and be completely chilled before it escapes to the body of the car. In cars equipped with open bulkheads, many local currents of partially chilled air pass through the bulkheads at various points.

The ability of refrigerator cars to refrigerate cantaloupe shipments and to maintain satisfactory temperatures in transit depends, also, upon the quality and quantity of insulating material employed in their construction. Tests have shown that the minimum requirements for the floors of refrigerator cars are 2 inches of cork, protected

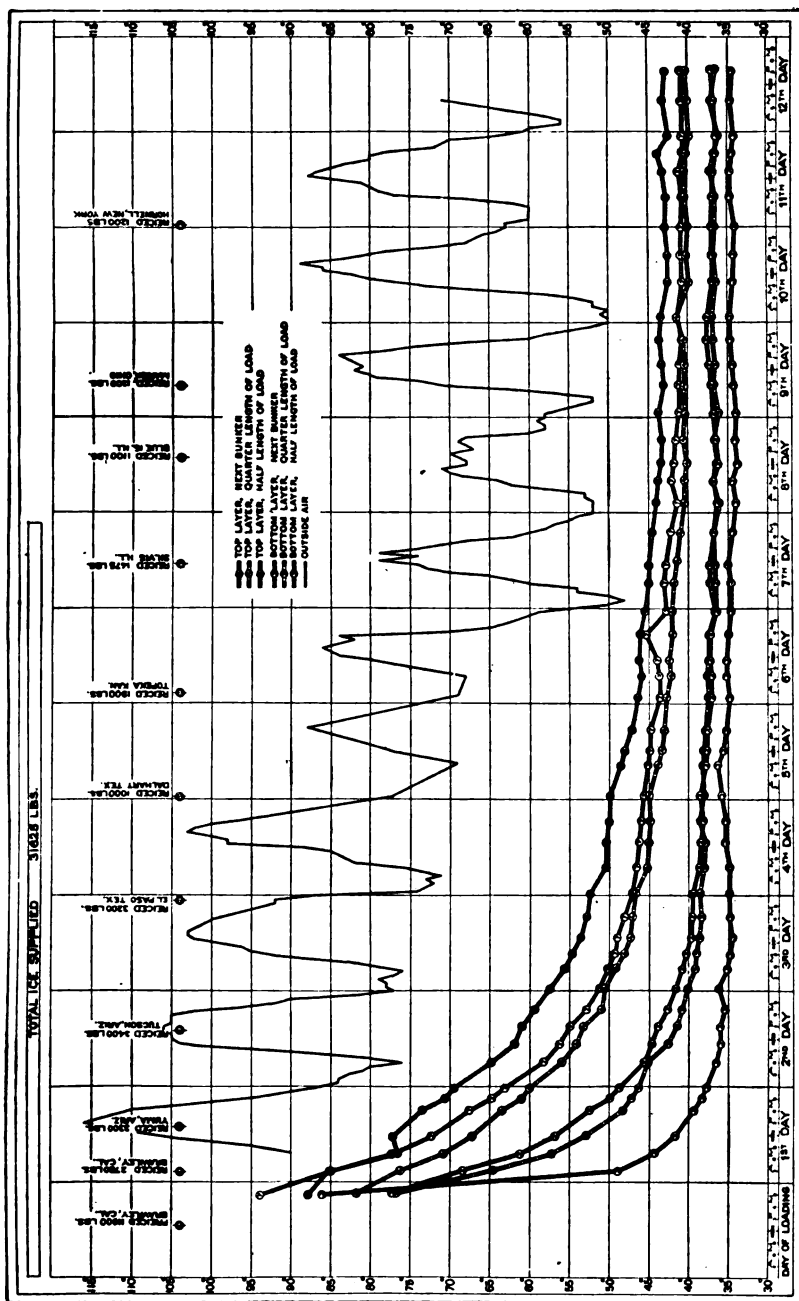


FIG. 5.—Diagram showing cantaloupe temperatures in a car equipped with open bulkheads and not equipped with floor racks. This car was in transit from Brawley, Calif., to New York, N. Y., June 28 to July 8, 1917.

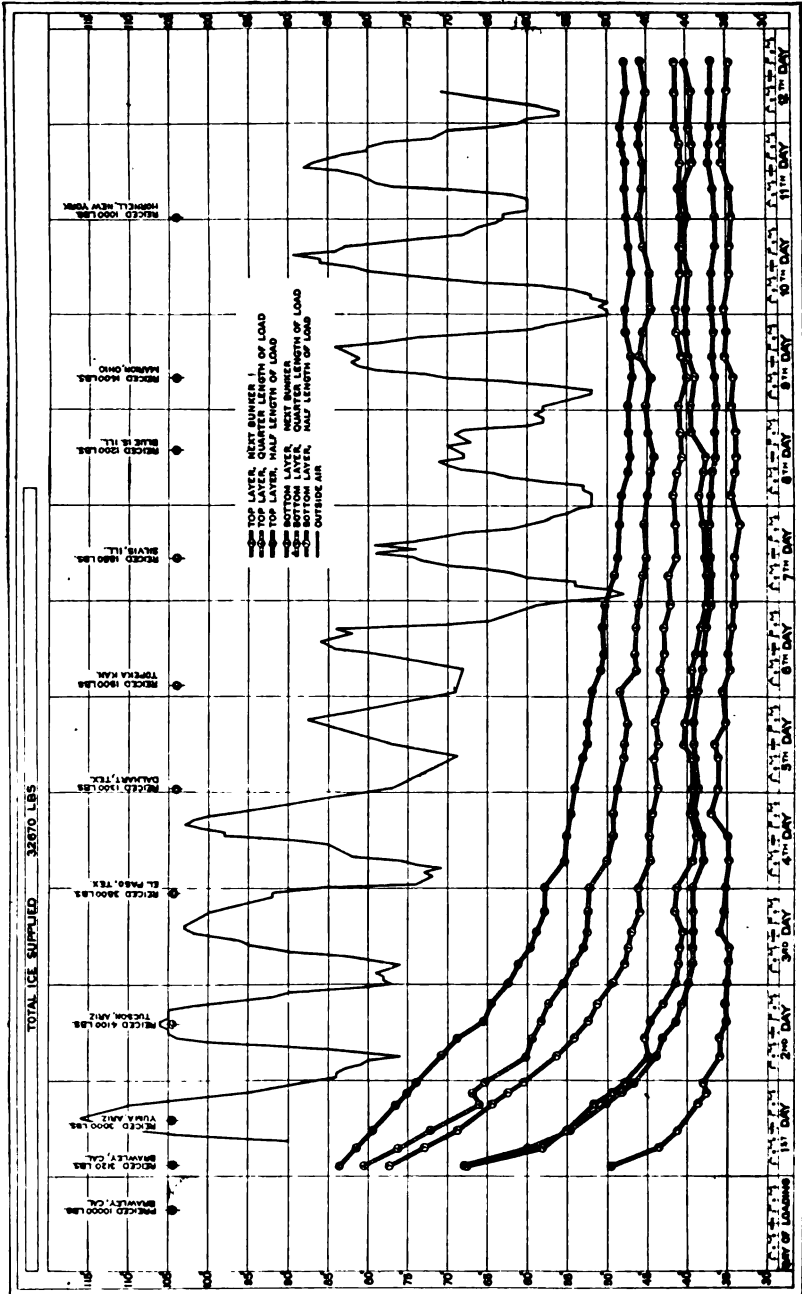


FIG. 6.—Diagram showing cantaloupe temperatures in a car similar in quantity of insulation to the car represented in figure 5, but of poorer construction and in poorer repair. This car was in transit from Brawley, Calif., to New York, N. Y., June 26 to July 8, 1917.

from moisture by waterproof paper, or other waterproofing material. For the walls, 2 inches of cork, or material which is equivalent to cork in heat transmission, are necessary, and for the roof $2\frac{1}{2}$ inches of insulating material, equivalent in heat transmission to $2\frac{1}{2}$ inches of cork. Equally as important as the amount and quality of insulating material employed is the method of its application to the car walls, and the attention paid to details in the construction, rebuilding or repairing of the cars.

The importance of these factors is illustrated by figure 6, which shows diagrammatically the temperatures obtained in a car of cantaloupes shipped from Brawley to New York City in June, 1917. This car may be compared with the car represented in figure 5. It contained an equal quantity of insulating material but was not of equally good construction, nor had it been so carefully inspected, or repaired, when repairs were necessary. The temperature differences are striking and illustrate the importance of close attention to details of construction and repair of refrigerator cars. An average of the top layer temperatures in these two cars is shown in figure 8.

The two upper curves in figure 9 represent the top layer temperature next to the bracing in the same cars. Attention is called to the heavy black lines in figure 9 representing the percentage of soft cantaloupes in the top layer of each of these cars when inspected at New York. Car A, it will be seen, arrived with 86 per cent soft, or all crates except those immediately against the two bulkheads. In Car B, 14.3 per cent of the melons in the top layer were soft.

SALT HASTENS REFRIGERATION.

The refrigeration of perishable shipments is effected by the melting of ice in the bunkers of the cars. If no ice is melted no cooling results. The rather common belief that the presence of ice in itself constitutes a source of refrigeration is not correct. The actual condition is comparable to the burning of coal to produce heat. It is the burning coal which produces heat; the mere presence of coal can not affect temperature conditions.

After the ice is melted, the resulting cold water has very little cooling effect in comparison with that of the ice in melting. One pound of ice will take up 144 heat units during the melting process, whereas the pound of water formed from the same ice will take up only 1 heat unit for each degree which it is warmed.

Ice made from pure water melts at exactly 32° Fahrenheit. When ice is melting in contact with air, its temperature must be 32° . If it were colder it would not be melting. It can not become warmer until after it is melted. When, however, salt is mixed with crushed ice, a mixture is formed which melts at a temperature lower than 32° . The temperature at which it melts depends on the percentage

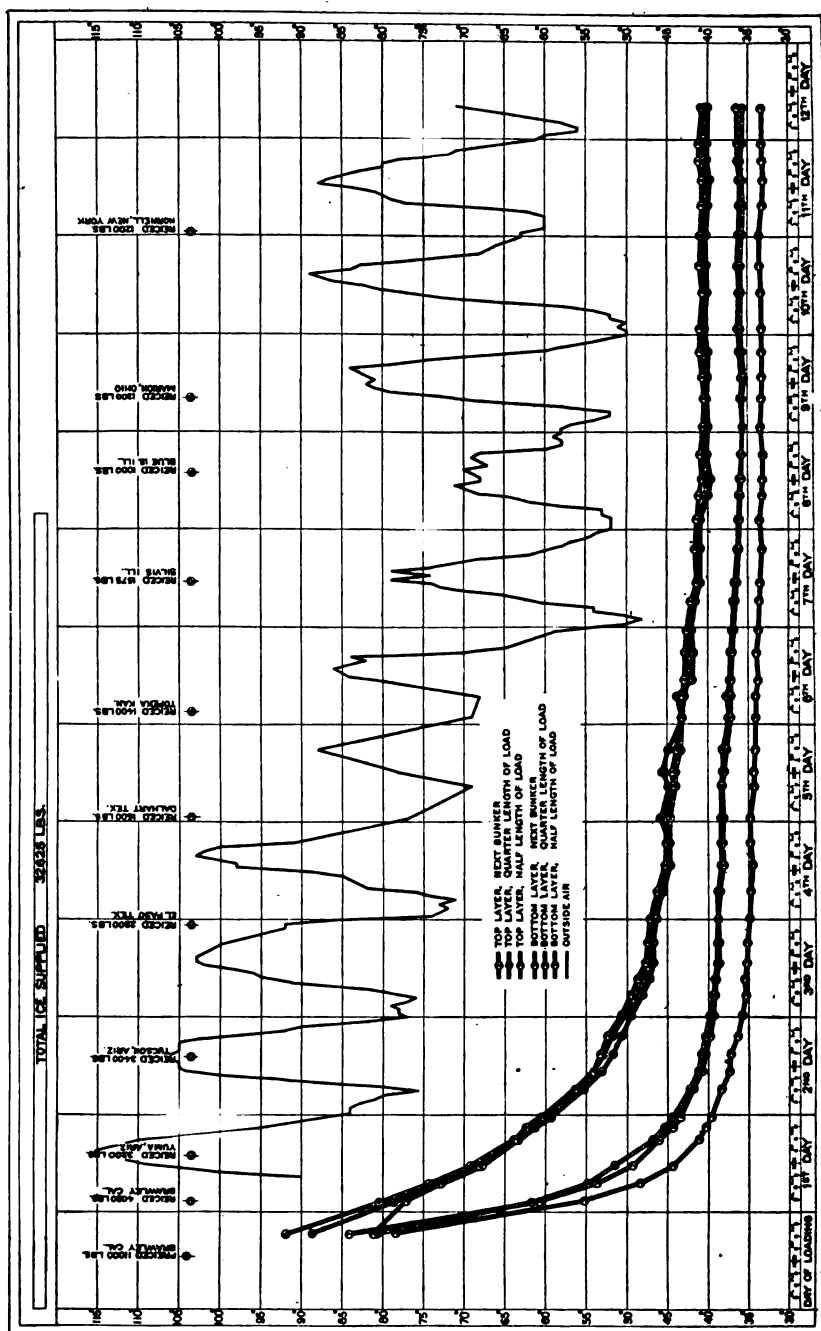


FIG. 7.—Diagram showing cantaloupe temperatures in a car equipped with basket bunkers, insulated bulkheads, and floor racks. This car was in transit from Brawley, Calif., to New York, N. Y., June 26 to July 8, 1917.

of salt and the thoroughness with which the salt is mixed with the ice. If the percentage of salt is increased, up to a certain limit, the melting temperature of the mixture is lowered. Twenty-five per cent salt and 75 per cent finely crushed ice, thoroughly mixed, melts

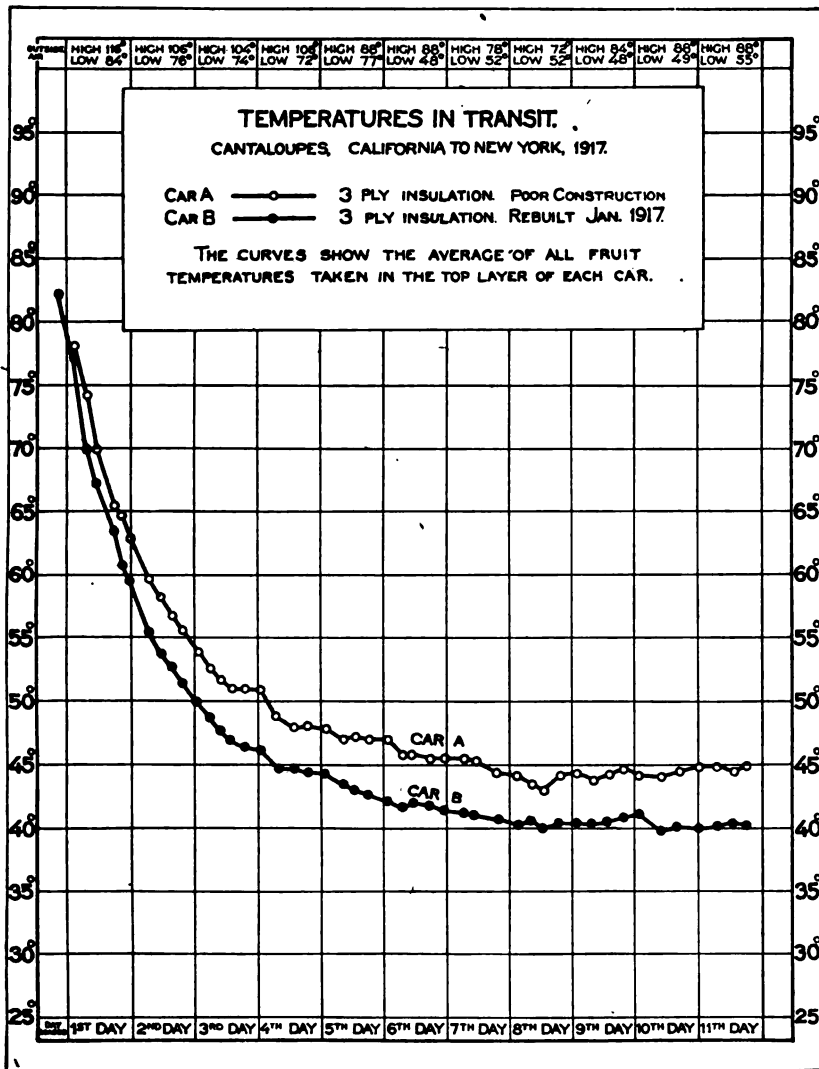


FIG. 8.—Diagram showing the average temperature of the melons in the top layers of the two cars represented in figures 5 and 6.

at about 3° or 4° below zero F. This is the lowest temperature which can be obtained with salt and ice. If still more salt is added, that is, if the mixture contains more than 25 per cent salt, the melting temperature will not be so low.

In an ice and salt mixture, the ice melts more rapidly than when ice alone is present on account of the lower temperature of the mixture. Consequently, heat is taken up more rapidly from the air and produce within the car and both are cooled to a lower temperature than is possible by the use of ice alone.

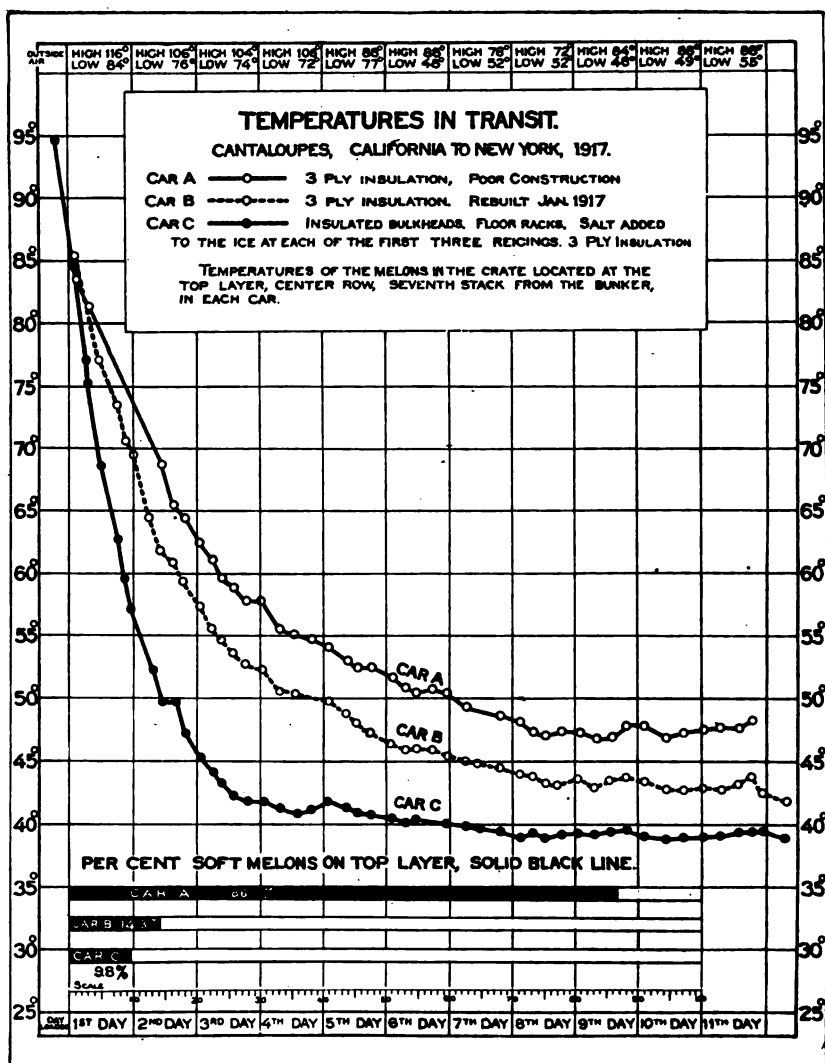


FIG. 9.—Diagram showing the warmest temperature of the melons, and the percentage of soft melons in the top layers, in the three cars represented in figures 5, 6, and 10.

Several experiments have been made to determine the additional cooling obtained by salting the ice in the bunkers of cars of cantaloupes immediately after loading. It has been determined that cooling is considerably hastened by this practice. When salt is used it should be added to the ice immediately after the car is loaded.

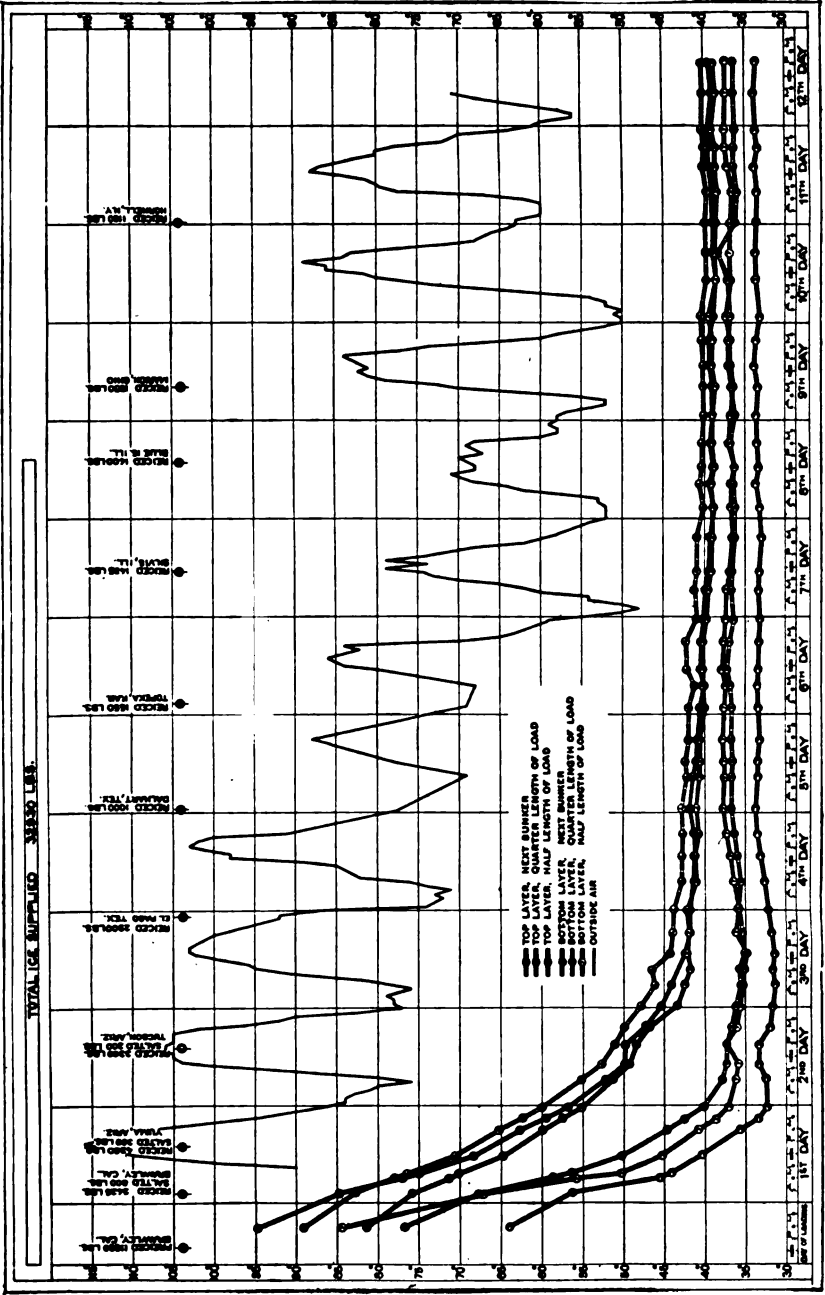


Fig. 10.—Diagram showing cantaloupe temperatures in a car equipped with basket bunkers, insulated bulkheads, and floor racks. Salt was added to the ice in this car as shown in the diagram. The car was in transit from Brawley, Calif., to New York, N. Y., June 26 to July 8, 1917.

The ice at the top of the bunker should be broken up into small pieces with an ice pick and the salt applied on top of the ice. Coarse salt, No. 2 or larger, is preferable. When the temperature of the melons is 80° F. or higher, 10 per cent of salt, approximately 500 pounds to each bunker, may be safely added at the first application. At the first icing station 100 to 150 pounds of salt may be applied to each bunker. If the temperature of the melons is below 80° F., the quantity of salt should be reduced, not more than 5 to 8 per cent being added at the first application, according to temperature conditions.

Salt should never be added to the ice except in cars equipped with floor racks, solid, insulated bunker bulkheads, and basket bunkers which provide a 2-inch air space around the ice. On account of the obstructions to air circulation in the ordinary refrigerator car, the use of salt in a car of this type merely serves to chill or freeze the melons at the floor of the car near the bulkhead without in any way hastening the cooling in the warmer portions of the load. With the improved construction already described, however, air circulation is continuous and unobstructed and there is no banking of cold air against the crates close to the bulkhead.

Figure 9 shows the top layer temperature at the bracing in a car in which salt was used (Car C) as compared with the temperature in the same location in two cars already described. This is usually the warmest portion of the load, and it will be seen that refrigeration is considerably hastened and the temperature materially lowered by the use of salt and the improved construction of Car C. It will be observed, also, that 9.8 per cent of the melons in the top layer of the latter car were considered "soft" from a marketing standpoint upon arrival at destination as compared with 86.0 in Car A, and 14.3 per cent in Car B.

Figure 10 shows the cantaloupe temperatures in transit at six positions in a car equipped with basket bunkers, insulated bulkheads, and floor racks, salt having been added as indicated, at the first three reicings after the car was loaded. The important showing in this car is the extremely rapid drop in temperature during the first 48 hours.



PUBLICATIONS OF THE U. S. DEPARTMENT OF AGRICULTURE RELATING TO THE HANDLING AND SHIPPING OF PERISHABLE FRUITS AND VEGETABLES.

DEPARTMENT BULLETINS.

Department Bulletin 601: Handling and Precooling of Florida Lettuce and Celery.
Department Bulletin 861: Marketing Eastern Grapes.

FARMERS' BULLETINS.

Farmers' Bulletin 707: Commercial Grading, Packing, and Shipping of Cantaloupes.
Farmers' Bulletin 753: Commercial Handling, Grading, and Marketing of Potatoes.
Farmers' Bulletin 1050: Handling and Loading Southern New Potatoes.
Farmers' Bulletin 1091: Protection of Potatoes from Cold in Transit—Lining and Loading Cars.
Farmers' Bulletin 1189: Handling Spinach for Long Distance Shipment.

MARKETS DOCUMENTS.

Markets Document 8: Factors in the Transportation of Strawberries from the Ozark Region.
Markets Document 13: Heavy Loading of Freight Cars in the Transportation of Northwestern Apples.
Markets Document 14: Loading American Grapes.

THE investigations of the Department of Agriculture were conducted during the shipping seasons of 1915, 1916, and 1917 in the producing sections of California, Arizona, and Colorado, and in the consuming centers of New York, Philadelphia, and Pittsburgh. The relation of the commercial practices of harvesting and preparing cantaloupes for shipment to carrying and keeping qualities in transit and distribution was studied as well as the influence of loading methods and modifications of car construction in retarding or accelerating refrigeration. Test trips were made from the Imperial Valley, Calif., Turlock, Calif. and Glendale, Ariz. In each test, the shipments under observation were loaded on the same day and the cars moved in the same train to destination. They were accompanied by representatives of the department, who at intervals, approximately five or six hours apart, secured a record of the temperature of the air and melons at 12 selected locations in each car. The observers also obtained a record of the atmospheric temperature, and, in most cases, of the actual weight of the ice supplied each car. The number of cars in each test varied from 4 to 13, the usual number being about 8.

The temperatures within the cars were obtained by specially constructed electrical thermometers. These thermometers were connected by short cables to a master cable. A small portion of the master cable, in the form of a flattened plate, passed out between the door and door frame to the roof of the car. Thus no opening was made that would permit an appreciable influx of hot air. The temperature readings were obtained from the roof of the car. By the use of this equipment, it was possible to obtain an accurate record of temperature conditions within the cars without opening the doors or ventilators at any time. It was also possible to obtain the temperature of melons in crates at the bottom of the load, and at other points where it would have been impossible to locate or read mercury thermometers.

Every effort was made to control each shipment tested, so that it differed from the others in the same test only with regard to the particular factor under investigation. This was accomplished in all cases, so far as it was possible under actual service conditions. The effects of loading methods, car construction, and refrigeration practices on the temperature of cantaloupes in transit are presented graphically in the illustrations accompanying the text.



DOURINE OF HORSES

J. R. MOHLER

Chief of the Bureau of Animal Industry

and

H. W. SCHOENING

Pathological Division



FARMERS' BULLETIN 1146

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Animal Industry

JOHN R. MOHLER, Chief

Washington, D. C.

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Division of Publications, United States Department of Agriculture

DOURINE is a specific infectious disease which under natural conditions affects only the horse and the ass. It is transmitted from animal to animal by coition, and is caused by a microscopic animal parasite, the *Trypanosoma equiperdum*. The first symptoms appear in the genital tract. The parasites then gain entrance into the blood stream and eventually attack the nervous system. The disease usually runs a chronic course, finally producing complete paralysis of the hind quarters and resulting in death.

Dourine has been described under various names according to the country in which it is found. Chief among them may be mentioned "el dourine," "maladie du coït," "covering disease," "equine syphilis," "genital glanders," "breeding paralysis," "chancrous epizootic," and "epizootic paraplegia." In the United States the most common name for the affection is the short and distinctive term "dourine," which is Arabic for unclean.

DOURINE OF HORSES.

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HISTORY OF EARLY OUTBREAKS.

DOURINE is supposed to have come from Asia, where the disease is believed to have existed for centuries. It is thought to have been introduced into continental Europe during the early part of the nineteenth century through the importation of breeding horses, especially Arab stallions, from the Orient.

In the United States the disease was first suspected in 1885 and definitely recognized in 1886 in Illinois. The infection was traced to a stallion imported from France in 1882. Officials of the State of Illinois took charge of the outbreak, and as a result of rigid measures the disease was eradicated from the State in 1888, but not before an infected stallion had been shipped to Gordon, Nebr., thereby setting up a new center of infection. Dourine broke out there in 1892, but was apparently eradicated through the control measures of the Bureau of Animal Industry, although it reappeared in 1899 and again in 1901 with increased vigor in the Pine Ridge and Rosebud Indian Reservations, S. Dak. The work of eradicating the disease in that section was continued until 1905, when the last suspicious cases were destroyed. Several outbreaks were also reported in Iowa, continuing until 1911. In each instance vigorous methods of control and eradication were adopted by both the State and Federal authorities.

At that time the methods of diagnosis were limited to a physical examination, which, owing to the nature of the disease, was unsatisfactory at its best. But in 1912, when dourine was again reported, this time in Montana, the reliability and practical application of blood tests had been determined. A test known as the complement-fixation test was used in diagnosing the disease; and by its use dourine was found to exist not only in Montana but also in North Dakota, South Dakota, Arizona, New Mexico, Wyoming, and Nebraska. It was most prevalent on the Indian reservations in some of those States. Since 1912 the disease has been eradicated from Nebraska, and a small outbreak that occurred in Iowa in 1915 was also stamped out, and the excellent progress made in the other States leads to the belief that its complete eradication will be accomplished in the near future.

In Canada the presence of dourine was discovered in 1904, and there also use is being made of the complement-fixation test as a means of diagnosis in controlling and eradicating the disease.

CAUSE AND TRANSMISSION OF THE DISEASE.

Dourine is a disease of breeding animals, and under natural conditions affects only horses and asses. However, it may be transmitted artificially not only to those animals but also to dogs, rabbits, rats, and other susceptible animals by means of inoculation with relatively large quantities of the blood and membranes of certain organs of animals affected with the disease. Copulation, however, is by far the most common means of transmission; other means are so rare that they have no practical importance in the adoption of measures for suppressing the disease.

The organism causing dourine is an animal parasite of microscopic size known scientifically as *Trypanosoma equiperdum*. This trypanosome has the ability to penetrate the intact lining of the genital tract, from which it reaches the blood and later the more distant parts of the body. Its disease-producing action seems to result from the production of certain poisons which act, first, on the end nerves and later on the general nervous system, leading to a degeneration of those parts.

Although the predisposition of horses and asses to the infection is marked, not all stallions which serve diseased mares or all mares served by infected stallions contract the disease. According to one authority, about 66 per cent of the mares exposed to infection become diseased. Cases are on record in which a healthy stallion has transmitted the disease from an infected to a healthy mare without contracting the disease himself.

A number of the animals affected with dourine are latent cases; that is, they do not show any perceptible symptoms of the disease, although it is possible for them, even in this stage, to infect others to which they are bred. Meanwhile any condition which tends to lower the vitality of the animal—as hard work, exposure, and lack of feed—may aggravate the disease and bring about the development of noticeable symptoms.

SYMPTOMS.

There are many variations in the symptoms of dourine, and this is particularly true of the disease as it exists in the United States. In order to give a fair idea of the symptoms that may be found it is necessary to describe manifestations which may appear in a number of horses. Each individual may have several but not all the symptoms enumerated.

Two distinct stages of the disease may be noted; the first concerns chiefly the sexual organs, but in the second stage, symptoms indicating an affection of the nervous system are more prominent. After exposure to infection and before symptoms of the disease appear there is a variable period ranging from 8 days to 2 months.

In the stallion there is first an irritation and swelling about the penis. The swelling extends throughout the organ, which may be continually protruded, with frequent erections. The swelling may also involve the groin, with an enlargement of the lymph glands in that region, and then extend forward along the abdomen. In a few days the penis shows small blisters, which break, discharging a yellowish fluid and leaving irregular, raw ulcers, which, if situated near one another, have a tendency to run together, resulting in a



FIG. 1.—Stallion in good condition at time of purchase. (Dourine afterwards developed.)

large raw surface with an irregular border. The ulcers show a tendency to heal rapidly, leaving white scars, which are permanent. In some cases the urinary opening is very red and swollen, and a yellowish fluid may drip from it. The stallion retains his breeding instinct and becomes very amorous when brought in the vicinity of mares. If allowed access to mares in season, service is often impossible, owing to the fact that a complete erection of the penis does not occur. The testicles may be involved and become tender to pressure, and abscess formation and sloughing may occur. In certain cases the initial symptoms may be so slight as to pass unnoticed, which is especially true of animals running on the open range and not seen by the owner for long periods.

In mares the disease, being the result of copulation, begins with swelling and inflammation of the genitals, exposing the clitoris, which

is continually in a state of erection. There may also be a discharge similar to that observed in the stallion, and it may be profuse or slight in quantity. The mare will switch the tail, appear uneasy, and urinate frequently. Vesicles or blisters soon appear on the external genitals as well as on the internal lining of those organs. The blisters soon rupture, which is the initial stage in the formation of deep, angry ulcers, which show a tendency to heal rapidly, invariably leaving a permanent scar and causing a slight puckering of the tissue. On the dark skin of the external genitals these scars are always



FIG. 2.—A chronic case of dourine. (Same stallion as shown in fig. 1 after the disease had developed.)

white, more or less circular in outline, from one-eighth to one-half inch in diameter, and pitlike, similar to the depression in a pock-mark. (See fig. 3.) These marks are permanent and not temporary as in coital exanthema and other affections resembling it. Swellings in the region of the genitals and the mammary glands frequently occur.

Sometimes the lesions described disappear gradually and the disease may remain in abeyance for months or even years. The apparent recovery, however, as a rule, is not permanent, and any excessive work or excitement, especially copulation, may set up the disease anew. Mares may abort during pregnancy, but many fine colts have been born to affected mares.

The nervous or constitutional disturbances of the second stage may not come on for months or even years after the appearance of the local lesions, and are similar in both male and female. They consist of a general nervous disorder with a staggering, swaying gait, espe-

cially in the hind legs. The animal becomes extremely emaciated, particularly in the hind quarters, and "tucked up" in the flanks.

The first indication in paralysis is noted in traveling, when the animal fails to pick up one of the hind feet as evenly as the other. There is a tendency to drag the foot partially, which will wear the toe off more than normal. This condition may shift from one hind foot to the other, or both may become affected simultaneously, and then knuckling is a common symptom.



FIG. 3.—Dourine involving the external genitals and perineum of a mare. Note the areas from which color has disappeared.

Only occasionally are the nerves of the forelegs and face affected, the latter being manifested in paralysis of an ear, an eyelid, a nostril, or a lip, or all combined. (See fig. 4.) Twitching of the superficial muscles has also been noticed in several instances. Swellings or plaques may break out on various parts of the body, especially on the croup, belly, or neck. They may disappear in a few days, only to reappear at some other point. These swellings are round, flat, and about the size of a half dollar, sometimes larger. When punctured, a bloody serum oozes out of the cut surface. Figure 5 illustrates the appearance of the plaques.

There may be noted also an inflammation of the skin which causes the animal to rub itself frequently, while spots may be present on the hind legs and in the region below the genitals, as a result of the discharge from the penis or vagina coming into contact with the skin and causing a destruction of the coloring matter.

The temperature of the animal seldom goes above 101° or 102° F. Labored breathing is occasionally noted, and in some cases the glands under the jaw swell and a discharge appears from the nostril, simulating glanders. When paralysis of the hind limbs appears it usually

progresses rapidly. The horse goes down, is unable to rise, and dies in a short time from nervous exhaustion. Until the last, however, the appetite remains good, and the stallion shows a desire for the mare, although service is impossible.

POST-MORTEM LESIONS.

The post-mortem lesions may vary considerably, depending on the severity of the initial attack of the disease and the length of time the animal has been affected. The following lesions may be noted, but their presence and extent are governed by conditions described.

In the mare the lining membrane of the vulva and vagina shows swelling and gelatinous infiltration, together with considerable congestion of the blood vessels.

The lining of the womb is

thickened and corrugated, and sometimes ulcers are present. The whole internal lining of the organ may be orange colored, may be covered with a discharge of mucous pus, and occasionally may show small, irregular, yellowish patches. The ovaries are frequently involved, and may show hemorrhages and a large blood clot in their interior. Where the discharge from the genital organs has come into contact with the skin there are irregular-shaped whitish spots.

In the male the penis is usually enlarged, although in some cases normal in size. It frequently contains ulcers or scar tissue on its surface or in the urethral canal. The sheath is also swollen and the



FIG. 4.—Showing facial paralysis.

skin thickened. The testicles in some cases are soft and smaller than normal, while in others the opposite is found. Adhesions may be found between the different coverings of the testicles. In nearly all cases the scrotum is infiltrated.

The lymphatic glands in the groin also are inflamed, and in many cases may be plainly visible as irregular, wavy lines under the skin. There is also a yellowish, gelatinous material beneath the skin in those areas where plaques were situated just before death. In cases of long duration there is more or less marked shrinkage of the muscular system, a condition naturally following the paralysis which

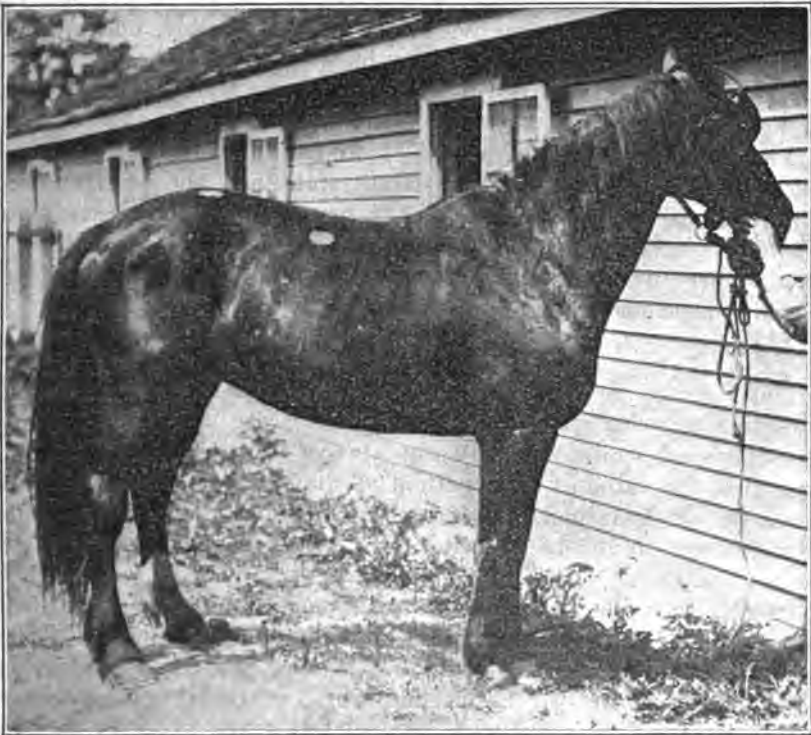


FIG. 5.—Showing plaques.

precedes death. Changes are noted in the brain, spinal cord, and spinal nerves, pointing to a degeneration of those parts, with an influx of fluid and formation of numerous hemorrhagic areas. The skeleton is also affected, and the bones may be softened. The bone marrow is congested, and hemorrhages and erosions may be seen on the articular cartilages of the joints. A discoloration of the joint fluid due to red blood cells is frequently seen, giving it a peculiar pinkish color.

COURSE AND OUTCOME OF THE DISEASE.

The course of the disease is extremely variable and may cover a long period of time. At the commencement of the attack the

genital symptoms alone are observable. Sooner or later, however, the case becomes complicated by the appearance of the systematic or nervous disturbances, including staggering gait, loss of flesh, and paralysis of the hind legs. As the symptoms become gradually intensified the animal goes down and death soon follows.

The course of the disease is markedly influenced by the conditions and environment to which the animal has been subjected. Bad weather, exposure, insufficient food, and complicating diseases like influenza, distemper, or, in fact, any condition which tends to lower the vitality of the animal, hastens the termination of the disease. On the other hand good care and abundant feed will prolong life and may even result in recovery. It is also possible, under favorable conditions, that an animal may have dourine in the latent form for years without manifesting any symptoms and yet be a source of danger.

Although now and then a case of dourine may recover, as a rule the disease is still present in a latent state, and the excitement of copulation is very likely to cause it to reappear with increased vigor. The outlook, therefore, is always to be considered unfavorable, and, in a country where a relatively small number of cases appear, tempering methods of suppressing the disease are not warranted.

DIAGNOSIS.

Until recent years the diagnosis of dourine in the field rested solely on physical examination. As the disease is of such a nature that physical symptoms may not always be present, it readily is seen that the value of that method of diagnosis is limited, for only cases in which animals showed physical symptoms at the time of examination would be detected, and latent cases would be overlooked entirely.

In 1912 the serum diagnosis of infectious diseases had been placed on a sound basis in veterinary as well as human medicine. The complement-fixation test used in the diagnosis of glanders in horses had proved to be entirely reliable, and when, in 1912, dourine was reported in Montana, steps were immediately taken to apply that test to dourine. After extensive experimental work a method was developed which gave satisfactory results, and the practical use of the test in the control and eradication of dourine in this country and in Canada has demonstrated its accuracy and value. In countries where but one trypanosome disease exists the complement-fixation test is of inestimable value as a diagnostic agent, for while the reaction to the test is the same for all diseases caused by pathogenic trypanosomes, dourine is the only disease of that kind known to exist in the United States. By the use of the complement-fixation test it is possible to detect even the latent cases of dourine. Animals affected with any other diseases existing in the United States do not react to the test for dourine.

The test is primarily a laboratory one, in which the blood serum of the suspected animal is utilized to determine whether the animal in question has been infected with the trypanosome of dourine. The principles of the complement-fixation reaction are recognized the scientific world over, and its technic is extensively employed in both human and veterinary medicine. The Wassermann test used in the diagnosis of syphilis in man is a complement-fixation reaction, while satisfactory results are obtained in the diagnosis of glanders in horses and contagious abortion in cattle by complement fixation.

The Bureau of Animal Industry will apply the test for dourine when samples of blood serum from animals suspected of being affected with or exposed to the disease are submitted for examination. As considerable skill and experience are required in properly preparing serum samples, this work should be done by a qualified veterinarian. The samples, prepared according to the directions which follow, should be forwarded to the Chief of the Bureau of Animal Industry, Pathological Division, Washington, D. C., and a letter giving a history of the samples should be mailed to him the same day.

DIRECTIONS FOR THE COLLECTION OF BLOOD SERUM FOR LABORATORY DIAGNOSIS.

As the serum is the constituent of the blood which is utilized in applying the complement-fixation test, it is extremely important to send good specimens to the laboratory in order that a conclusive and reliable diagnosis may be made. To obtain a good, clear specimen of serum the following procedure is recommended:

Draw 4 ounces or more of blood from the jugular vein of the suspected animal into a dry, clean, preferably sterile, wide-mouthed bottle. The blood should not be collected until a steady stream flows from the cannula of the trocar. After the bottle is filled set it carefully to one side and allow it to stand for at least 30 minutes, or until complete coagulation has taken place. It is important to see that the blood is not disturbed until complete coagulation has occurred, as the serum will not separate so readily if agitated before coagulation takes place. The sample may then be moved if desired. The clotted blood should be allowed to stand for six hours longer, or until the clear yellow serum separates from the clot.

When a sufficient quantity of serum has separated from the clot pour off from 2 to 4 drams into a small vial, being very careful not to allow the entrance of any red cells. If after six hours the clot fails to contract sufficiently to allow the yellow serum to separate from it, the process may be accomplished by carefully loosening the clotted blood from the sides of the bottle by means of a sterile wire. The sample is then permitted to stand long enough for the clot to contract, leaving the clear yellow serum above, which should then be poured on.

If the sample is to be shipped a considerable distance or in warm weather, the serum should be carbolyzed 0.5 per cent by adding 1 part of a 5 per cent solution of carbolic acid to 9 parts of serum. It is important not to exceed those proportions of carbolic acid and serum.

The vial in which the serum is to be forwarded should be properly labeled, giving (a) a description of the animal from which the sample was obtained—whether a horse or an ass, (b) owner's name and address, and (c) name of person sending the sample.

TREATMENT.

Little benefit can be obtained from the medicinal treatment of dourine, nor is such treatment desirable in this country where the

disease has existed only in restricted areas and where sanitary considerations demand its prompt extirpation.

The Bureau of Animal Industry nevertheless has conducted experiments along lines of treatment in animals affected with the disease. Various drugs likely to be most useful in combating trypanosome infection were used, but the results were unsatisfactory. The very high cost of these drugs, together with the expense of handling the animals, would make such treatment impracticable even though beneficial results had been obtained.

METHOD OF ERADICATION.

Sanitary measures looking to the eradication of dourine must depend on the principle that horses infected with the disease should be prevented from breeding. This conclusion is well founded, for in spite of the possibility of recovery there are, as a matter of fact, frequent relapses, and trypanosomes may exist for many months in the sexual organs of animals apparently recovered. Therefore it is very essential to destroy diseased animals as soon as possible. The objections to spaying the mares and castrating the stallions is that such mares on the open range may be covered by stallions and that infected stallions even after castration may cover healthy mares.

Dourine, being conveyed under natural conditions solely by the act of coition, is not a difficult disease to stamp out in a farming community, but eradication is a more difficult task on the open range. With good cooperation among Federal Government officials, State authorities, and horse owners, however, these difficulties can be overcome.

A number of the veterinarians of the Bureau of Animal Industry are stationed in States where dourine exists, and they cooperate with the State veterinarians and their deputies in the work of eradication. In the spring of the year, before the animals are bred, samples of blood serum are drawn from all breeding animals in districts where dourine exists or is suspected. These samples of serum are properly identified and forwarded to the Pathological Division of the bureau and are subjected to the complement-fixation test for dourine. The animals are held in virtual quarantine until the results of the test are received. Animals whose serums give positive results are destroyed. The owner is reimbursed for the loss of the animal, the State and Federal Governments sharing the expense equally, but not to exceed \$100 on the part of the latter. On the Indian reservations the entire expense is borne by the Federal Government. Animals whose serums give negative results are considered to be free of infection and are released for breeding.

About 50,000 samples of serum are tested annually. The percentage of reactors is growing smaller each year, and the outlook for the complete eradication of dourine in the near future is bright.

MILO, A VALUABLE GRAIN CROP

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FARMERS' BULLETIN 1147

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry

WM. A. TAYLOR, Chief

Washington, D. C.

November, 1920

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Division of Publications, United States Department of Agriculture

MILO is one of the important grain-sorghum crops in the southern Great Plains area. Approximately 1,205,000 acres were grown in 1918, with a value of \$21,300,000.

Milo was introduced into this country soon after 1880. It has been much improved since then. Four varieties of milo—Standard milo, Dwarf milo, White milo, and Dwarf White milo—are now grown to some extent. Dwarf milo probably occupies a larger acreage than all the other varieties combined.

The milos produce better than other grain sorghums where the rainfall is low and the altitude high. Dwarf milo leads in yield in sections where the elevation ranges up to 4,000 feet and where the annual rainfall is 20 inches or less.

Further progress is possible in increasing the quality and yield of milo. The best and surest way to improve the crop is for each farmer to select his seed, prepare a good seed bed, and give the crop good, clean cultivation.

The milo crop is used for feed for all kinds of stock. The grain is used to a slight extent as food for man.

MILO, A VALUABLE GRAIN CROP.

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VALUE OF MILO.

MILO has long since passed the experimental stage as a farm crop in the southwestern United States. The rapid increase in its acreage and value in the past 19 years is evidence of that fact. In 1899 approximately 25,000 acres were devoted to milo in this country, with an aggregate value of \$200,000. By 1909 the crop area had increased to 307,000 acres, with a value of \$2,900,000, while in 1918 the crop was estimated at 1,205,000 acres, valued at \$21,300,000. Thus the acreage has increased to nearly 50 times that of 1899, while the value is more than 100 times as great. The increase in acreage in the 10 years from 1909 to 1918, inclusive, has been rapid and substantial. It amounts to a total of about 900,000 acres, with an added value of \$18,400,000.

Milo has not yet reached its economic limits in either acreage or production. These should increase still further as the value and the adaptation of the crop are more generally understood. Many acres of land in the district where milo is adapted which are now unused or devoted to other less profitable crops may be used to advantage by growing milo.

HISTORY OF MILO.

Milo made its first appearance in this country soon after 1880. Its source is not definitely known. Africa probably is the home

of milo, but no sorghum since brought from there is exactly like it. One variety from Egypt, called yellow durra, is similar to milo, but it does not yield as well as milo under our conditions.

Milo was first grown in South Carolina or Georgia, and was widely advertised by an Atlanta seed firm in the spring of 1887. In some way it was introduced into western Texas, and has spread over the dry sections of that and adjoining States. Milo supplied a much-needed crop in that section of the country, because it is able to produce grain and forage under conditions where corn and other less well adapted crops fail. The acreage is steadily increasing there, but in the Southern States, under humid conditions, milo can not compete with corn. Therefore in South Carolina and Georgia, where it was first grown, its culture has practically ceased.

CHARACTERS OF MILO.

The stalks of milo are of medium size, dry, and pithy. They grow to a height of 5 to 8 feet and bear 8 to 10 rather short, narrow leaves. The heads are large, ovoid or oval, compact, and either erect or pendent. The glumes are black, hairy, and transversely wrinkled. The seeds are large, salmon (yellowish pink) or white, much flattened, and are about one-third inclosed in the hull.

When milo was first introduced it was tall, nonuniform in height, and produced many suckers and branches. A large percentage of the heads were pendent (fig. 1). These characters, which are objectionable in a grain crop, developed to a large degree whether the crop was grown under favorable or unfavorable conditions. Tall and nonuniform grain crops can not be harvested readily either by hand or with machinery. The grain from suckers and branches usually is not ripe when the crop should be harvested. Suckers may mature as early as the main stalk, but branches seldom do. Immature seed from branches and suckers lowers the grade and keeping qualities of the grain. The pendent heads catch on the machinery and delay all operations connected with harvesting and thrashing. If tied into bundles, the tops are larger than the bottoms, making the bundles difficult to shock so that the shocks will shed water.

When first introduced milo possessed some characters desirable in a grain crop. It was fairly early, drought resistant, productive, and had good seed-holding power. Some grain-sorghum varieties shatter freely when left in the field until overripe, but milo does not. By reducing or eliminating the undesirable characters and improving the desirable ones by selection, milo has been made one of the leading grain-sorghum crops.

The carefully selected milo is a great improvement over the common milo of the past. It has been reduced to a uniform height of about 5 feet when grown in the Plains region at an altitude of 3,000 to 4,000 feet above sea level. The heads have been changed from mostly pendent to mostly erect under average dry-land conditions. A very small percentage of the heads of the improved strains are pendent, i. e., declined below the horizontal line, when grown under average conditions. Many heads are slightly inclined, but for all practical purposes this is not a serious objection. Such heads may be harvested readily by hand, with a row binder, or with a grain header without difficulty. Branching has been practically eliminated, and the tendency to sucker under normal growing conditions has been much reduced. Earliness has been increased until now these strains ripen in 90 to 110 days in the Panhandle of Texas and adjacent territory. The grain yield has been increased, and the quality of the grain has been improved.



FIG. 1.—Field of ordinary unselected milo, from 6 to 7½ feet tall, with stout, branched stems and pendent heads.



FIG. 2.—Field of milo improved by selection, from 4 to 4½ feet tall, slender, without branches, heads erect.

ADAPTATION.

Milo is well adapted to the semiarid conditions of the southern Great Plains area. It is a warm-weather plant and naturally does best in a warm, sunny climate. Milo requires less water than corn and is less susceptible to damage from hot, drying winds. It is earlier than any of the kafir varieties, which makes its growth possible in shorter seasons and at higher altitudes. Better results usually can be expected from milo than from kafir at altitudes ranging from 2,000 to 4,000 feet where the average annual rainfall ranges from 15 to 20 inches. The northern boundary of Kansas is about the northern limit for milo. Corn is a better crop than milo north of that line.

IMPORTANCE OF THE CROP.

Milo has many times demonstrated its importance in certain sections of Kansas, Oklahoma, Texas, Colorado, and New Mexico. It has proved to be the surest and most productive feed grain crop that can be grown in certain localities in these States, owing primarily to its ability to grow in comparatively short seasons and at high altitudes, characterized by hot summer days, low rainfall, and long droughty periods.

Good crops of milo are produced under an annual rainfall of 15 to 20 inches and with a seasonal (April to September) rainfall of

8 to 12 inches, when distributed to the advantage of the growing crop.

Milo has proved an important crop under irrigation in southern Arizona and California. It produces higher yields than other varieties of grain sorghum and can be sown after small grain is harvested, making possible the growing of two grain crops on the land in one year.

VARIETIES OF MILO.

There are now four well-known varieties of milo, viz, Standard milo, Dwarf milo, White milo, and Dwarf White milo. These differ mainly in the height of the plants, color of the seed, and in productiveness under semiarid conditions.

STANDARD MILO.

Standard milo is a direct descendant of the milo which was first introduced into this country. It has been much improved through selection for shorter stalks, earliness, uniformity in ripening, and more uniformly erect heads. This is the crop now grown commercially under the name Standard milo in much of the southern half of the Great Plains area. In that section it grows to a height of 5 to 6 feet and produces good yields of grain in average seasons. Plants of this variety are shown in figure 2.

DWARF MILO.

Dwarf milo is probably a mutation of Standard milo. These two varieties differ chiefly in height and productiveness under dry conditions and at high altitudes. When grown under similar conditions Dwarf milo is consistently 12 to 18 inches shorter than Standard milo (fig. 3). Dwarf milo usually outyields Standard milo on the plains of the Texas Panhandle and adjacent territory. This variety is increasing in popularity among growers and is re-



FIG. 3.—Standard milo (right) and Dwarf milo (left).



FIG. 4.—Plants of Dwarf milo.

placing the Standard variety to a large extent. Plants of this variety are shown in figure 4.

WHITE MILO.

White milo is quite like Standard milo in every respect, except in the color of the seed. The seeds of this variety are creamy white, usually shading into yellowish pink at the tip, while those of the Standard variety are yellowish pink or salmon throughout.

Little is known of the early history of White milo. It probably was introduced about 25 or 30 years ago. It has been under cultivation in scattered localities in western Texas and Oklahoma for at least 10 or 12 years. White milo has no advantage over the Standard variety and does not compete with the Dwarf variety in yield. It has no character which would cause farmers to grow it in preference to the Standard variety. Therefore, the acreage is small and not likely to increase very much.

DWARF WHITE MILO.

Dwarf White milo bears the same relation to White milo that Dwarf milo does to Standard milo. It undoubtedly is a mutation of White milo. Dwarf White milo appeared under cultivation a few years ago on the Plains of Texas and Oklahoma. It is well adapted to conditions obtaining there, and good yields have been reported in recent years.

YIELD OF MILO.

The milos had a higher average yield in the 11-year period from 1908 to 1918, inclusive, than any other group of grain-sorghum varieties at the Cereal Field Station, Amarillo, Tex. This station is located in the Texas Panhandle at an altitude of 3,600 feet and has an average annual rainfall of 21 inches. In that 11-year period the best strain of Standard milo averaged 20 bushels to the acre and the best Dwarf milo averaged 24 bushels. White milo averaged 18 bushels per acre during the nine years beginning in 1910. Feterita has an average yield of 21 bushels, and Dawn kafir, which is the best variety of the kafir group, 16 bushels in the 11-year period from 1908 to 1918, inclusive.

The foregoing figures show that Dwarf milo leads all others by a substantial margin in the Amarillo section of the Texas Panhandle. It also leads all other varieties in grain production at the Dalhart Field Station, Dalhart, Tex. This station is situated at an altitude of 3,900 feet. At the Tucumcari Field Station, Tucumcari, N. Mex., the average yield of Dwarf milo was 22 bushels and that of Dawn kafir 22.7 bushels for the 6-year period from 1913 to 1918, inclusive. The best Dwarf milo averaged 16.8 bushels and the best kafir averaged 22.7 bushels in the 5-year period from 1914 to 1918, inclusive, at the Woodward Field Station, Woodward, Okla. This station is located in the northwestern part of the State at an altitude of 1,900 feet and has an average annual rainfall of 24 inches. At the Lawton Field Station, Lawton, Okla., the kafirs are more reliable than the milos, owing primarily to the attacks of chinch bugs. This insect damages milo to a greater extent than it does the kafirs.

Data taken from the report of the Kansas State Board of Agriculture show that in the 4-year period from 1915 to 1918, inclusive, the average yield of the milos was higher than that of either kafir or feterita in 25 of the 46 counties of the State west of the ninety-eighth meridian. These 25 counties lie mostly in the southwestern portion of the State. The average yield of milo was approximately equal to that of the other grain-sorghum varieties in 12 other counties. Thus it is seen that milo is more productive than other grain sorghums in western Kansas.

HOW TO INCREASE THE YIELD.

Although marked improvement has been made in increasing the yield and quality of milo, there still is room for further advances. Much of the crop shows a mixture of many types and hybrids. The yield and quality of grain from such mixtures usually are not as

high as from pure varieties; therefore the use of mixed seed and seed from unknown sources should be avoided as far as possible.

Milo readily crosses with all other sorghums, including broom corn and Sudan grass, when grown near them. Such crosses produce inferior hybrids which are not uniform in height and ripening, and many of them produce little, if any, grain. If the bulk grain from such crops is used for sowing, the succeeding crops will produce decreased yields of inferior grain.

The best seed should be used for sowing. The surest way to obtain this is for each farmer to select and save his own milo seed. This should be done before the main crop is harvested by going through the field and selecting a number of the best heads. Uniformity should be the watchword in making seed selection. The main points to be considered in selecting seed heads are: (1) Uniformity in height of plants, (2) uniformity in earliness, (3) uniformity in size and shape of the heads, (4) productiveness, (5) drought resistance, (6) freedom from branches and suckers, and (7) erectness of heads. Ordinarily, early dwarf plants with large heads should be selected. Well-formed milo heads are shown in figure 5.

SOIL REQUIREMENTS.

In soil requirements, milo is quite like other sorghums and corn. In the sections where milo is a staple crop, moisture is the limiting factor in production rather than soil fertility. Sandy loam soils produce good crops of milo with less rainfall than heavy soils or very light ones.

PREPARING THE SEED BED.

PLOWING THE LAND.

The time to plow and the depth at which plowing should be done depend largely upon the nature of the soil, the amount of moisture it contains, and the surface covering. Conservation of moisture is the prime factor in the region where milo is grown. The man on the land is the best judge as to the time and depth of plowing which will serve this purpose best.

Growing weeds rob the soil of moisture, while dead ones and grain stubble catch the snow and help prevent it and the surface soil from blowing off the fields during high winds in winter. The relative value of fall and of spring plowing is determined by the amount of moisture each will conserve. If heavy rains come early in the fall and plowing can be done before the weeds use the moisture, fall plowing is desirable. Otherwise, nothing is gained in this respect. However, late fall or winter plowing helps to distribute farm labor to good advantage and tends to avoid a congestion of spring work.

Soil subject to blowing should be listed instead of plowed. The lister furrows largely prevent soil blowing. If listing is done in the fall, the furrows will catch the snow and prevent much of it from being blown off the field.

HARROWING.

Plowed land should be worked into a compact, even seed bed before the crop is sown. This usually can be done best with the disk and spike-tooth harrows. The work necessary to make a compact seed bed depends upon the nature and condition of the soil. A deep working with the disk usually should be given first. This will pulverize the soil to a good depth and destroy weeds. Later the land should be worked at least once with the spike-tooth harrow, which will level the surface soil to some extent and kill weeds which are just starting. More work may be necessary on some soils, but it is not desirable to work the surface into a fine dust mulch. Most soils in that condition blow readily in high winds or puddle and crust when rain comes.

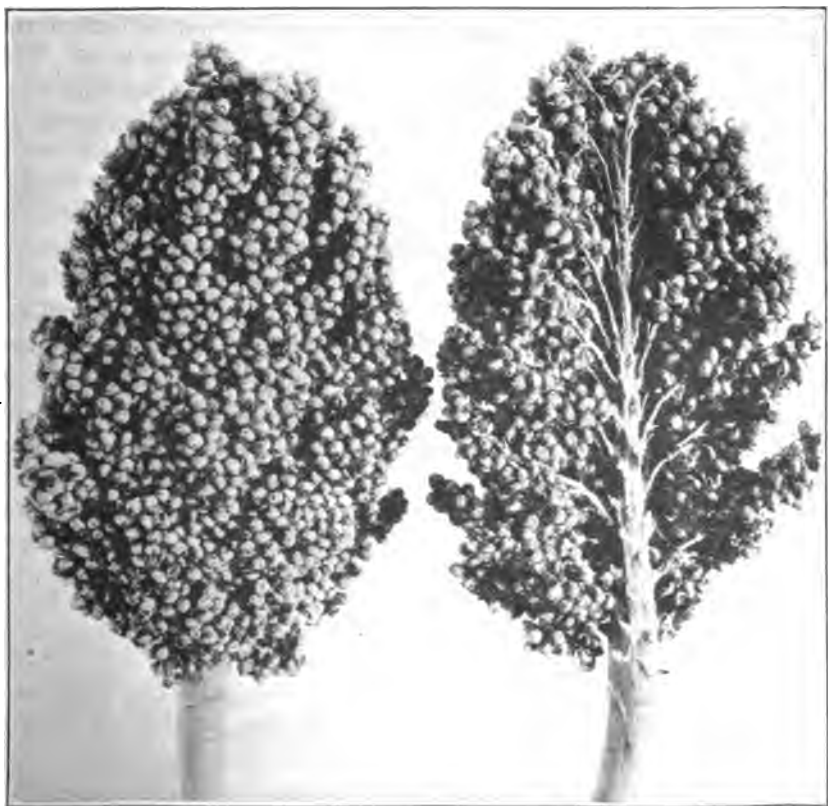


FIG. 5.—Good type of milo head, showing inside construction at right.



FIG. 6.—A 2-row surface drill in operation, Amarillo, Tex.

Listed land may be worked down with the disk harrow just before seeding time and then relisted when the crop is sown. The seed may be sown with an ordinary corn planter without relisting the land. However, listing is best where the soil is likely to blow. The lister furrows not only help to prevent soil blowing, but they also protect the young plants from being cut off by moving particles of soil.

SOWING THE CROP.

HOW TO SOW.

Seeding is done either with an ordinary corn planter or a lister fitted with sorghum plates. The seed should be drilled in rows about $3\frac{1}{2}$ feet apart. It may be surface sown or listed. That method should be used which experience has proved best for similar crops in any given locality. Surface-sown seed usually comes up sooner than listed seed, because the surface soil warms up quicker than the bottom of the lister furrows. Figure 6 shows a 2-row planter in operation on a well-prepared seed bed at Amarillo, Tex., and figure 7 shows a 2-row lister in operation at Hays, Kans.

WHEN TO SOW.

Milo is a warm-climate plant, and the seed will not germinate readily in cold soil. Seeding should not be done until after the surface soil is warm. This is usually from 10 days to 2 weeks after the average date for planting corn in any given locality.

In the Panhandles of Texas and Oklahoma seeding should start about May 15, and it can not be delayed much later than June 15. At

lower altitudes farther east and south seeding may start earlier and continue later than the dates mentioned. Seeding must not be delayed too late, or early frost will catch the crop before it can mature. Milo requires from 90 to 110 days to mature, depending on the season.

HOW MUCH TO SOW.

Usually from 2 to 3 pounds of milo seed are required to sow an acre. In dry seasons thin stands give best results, and in wet seasons thick stands yield highest. A stand with about 10 inches of row space to the plant in rows spaced $3\frac{1}{2}$ feet apart has given the highest average yield in a series of years at the Cereal Field Station at Amarillo, Tex. Like results may be expected in other localities with similar conditions.

On plump viable seed should be used. All hulls and small, cracked, and immature kernels should be screened or blown out by the use of a fanning mill. It is not possible to have the plants distributed uniformly in the row unless clean seed is used.

CULTIVATION.

Cultivation should be started early and be repeated often enough to keep the weeds down and the surface soil loose. The young plants grow slowly at first, and their growth may be further retarded or the plants entirely destroyed if weeds are allowed to grow in large numbers. Milo and weeds can not grow on the land at the same time without results unfavorable to the milo. A worthless weed may use as much moisture as a milo plant uses.

The spike-tooth harrow gives very good results for the first two cultivations of surface-sown milo. The first harrowing should be



FIG. 7.—A 2-row lister in operation, Hays, Kans.

done about the time the plants are emerging, and the second one just before the plants are large enough to be satisfactorily worked with the row cultivator. This will keep the surface soil loose, thus aiding the young plants to make a good start and destroying the weed seeds which are germinating. The harrow teeth must be set slanting back at an angle, so that they will not dig into the soil deep enough to pull out the young plants. It is best to cultivate the listed crop with the lister cultivator. While the plants are small the disks are set to turn the soil away from them; later, the disks are reversed to throw the soil to the plants. Thus the furrows are filled and the ridges leveled as cultivation continues. After the ridges have been leveled, an ordinary cultivator must be used if further cultivation is given.

HARVESTING.

There are three practical ways of harvesting milo: (1) Cutting the heads from the standing stalks by hand with a knife and throwing them into a wagon box, the same as husked corn; (2) using a corn binder which cuts the stalks off near the ground and ties them in bundles; and (3) using a grain header. The method to be used by any individual farmer depends upon the use to be made of the crop, the supply and cost of labor, and the acreage of the crop to be harvested.

In the first and third methods of harvesting, the stover is not used except for pasture. If the acreage is small, cutting the heads by hand is usually a satisfactory way of harvesting. By the use of the grain header more acres can be harvested in a shorter time, and this method should be employed where the acreage is large.

CURING.

Milo must be cured before it is thrashed or stored for the winter. This may be done in several practical ways if the heads only are harvested. They may be piled in long, narrow windrows or small piles on sod and left until cured, or they may be put into well-ventilated cribs. The latter method of curing is preferable, because the heads are protected from discoloration or other damage from damp or rainy weather. The cribs need not necessarily be built of expensive materials. They may consist simply of posts set into the ground with wire netting or fencing stretched around them to hold the heads in place. A roof which will protect the heads from rain and snow should be provided. This may be made of any material at hand which will turn water. The cribs should not be more than 6 or 7 feet wide, so that the air can circulate through them and prevent the mass of heads from molding.

When the plants are harvested and tied into bundles these are set in shocks to cure. The shock should contain not more than 12 or 15 bundles each. The air can not circulate through the shock if it is made too large, and the bundles in the center will mold. A field of milo in the shock is shown in figure 8.

THRASHING.

An ordinary grain separator is used for thrashing milo, but care must be taken to prevent the kernels from being cracked. Milo is larger and softer than wheat and will not stand as close or as hard thrashing. The close adjustment of the concaves and cylinder and the high speed of the latter, which is necessary for thrashing wheat, will crack a large percentage of the milo kernels. Therefore it is necessary to readjust the cylinder and concaves for thrashing milo. More space must be provided for the milo heads to pass through, and the speed of the cylinder must be reduced. Very satisfactory results are accomplished by removing about half of the concave teeth and then running the cylinder at about two-thirds of the speed used in thrashing wheat. This may be done by the use of a larger pulley on the cylinder shaft.

When the crop is cured in the bundle the heads should be cut from the stalks before thrashing. This is done readily by laying the bundles across a block and chopping the heads off by a single blow with a large axe, or with a long knife hinged at one end and mounted on a frame or on the wagon box. It is possible to run the whole bundles through the separator, but this method is not satisfactory if the stalks are long or heavy. The coarse, heavy butts of the stalks



FIG. 8.—A field of milo in the shock.

clog the shakers in a short time, which makes it necessary to stop the machine so that they may be removed by hand.

STORING THE GRAIN.

Milo, like other sorghum grain or corn, will get out of condition when stored in large bulk for any considerable length of time. The drier and cleaner the grain, the longer it will keep when stored. Moisture, cracked kernels, and dirt are the principal factors which cause the grain to spoil. Of these factors, moisture probably is the most common cause of trouble. Cracked kernels absorb more moisture from the air, are more susceptible to mold, and pack closer than whole ones. Small bits of trash or dirt of any kind absorb moisture and exclude the air, which causes the grain to heat and starts fermentation.

The average moisture content of milo is not as high as that of corn. However, when the water content is above normal the grain will heat readily if not handled carefully. The grain should be dry before it is stored in bins. The cracked kernels and dirt also should be screened or blown out. The risk from damage in storage will be much smaller if these precautions are taken. The cracked grain or screenings is not necessarily a loss, as it may be used for feed before spoiling.

If stored in bulk, the grain should be watched and stirred or moved so that air can pass through to dry and cool it if heating starts. This can be done readily in grain terminals and elevators where room and necessary machinery are available, by elevating the grain from one bin to another. On farms not equipped for handling the grain in that way, the bins should be small and well ventilated or the grain should be stored in bags.

CHEMICAL COMPOSITION OF THE GRAIN.

The average of 139 analyses shows that milo grain contains 9.31 per cent of water, 1.61 per cent of ash, 1.99 per cent of nitrogen, 12.49 per cent of protein, 71.88 per cent of carbohydrates, 3.22 per cent of fat, and 1.48 per cent of fiber. These samples were grown at the Amarillo Cereal Field Station, Amarillo, Tex., in the eight years from 1908 to 1912 and 1914 to 1916, inclusive. The analyses were made by the Plant-Chemical Laboratory of the Bureau of Chemistry, United States Department of Agriculture. For comparison, the average of 86 analyses of dent corn are given: Water, 10.60 per cent; ash, 1.50 per cent; protein, 10.30 per cent; carbohydrates, 70.40 per cent; fat, 5 per cent; and fiber, 2.20 per cent. These samples of corn

were grown in different years and in different States and were analyzed in various places. They may not be directly comparable with the analyses of milo samples which were grown at one place and analyzed in one laboratory, but they are probably fairly representative of the average corn used for feeding purposes.

Milo is seen to be higher in protein content and in carbohydrates than corn. The fat content, which is the most valuable part of the grain for fattening stock, pound for pound, is lower in milo than in corn. Fat in the feeding ration has an effect similar to that of a concentrated carbohydrate, which makes corn distinctly richer in that respect than milo.

The digestibility of the starches in grain largely determines its feeding value. Experiments made in the past 18 years with cattle and hogs to determine the digestibility of sorghum grain agree in general that the starch of the sorghum grains is less digestible than that of corn. The difference averages about 10 per cent, which gives the sorghum grain about 90 per cent of the feeding value of corn.

USES OF THE CROP.

The milo crop is used for feeding all kinds of stock. It may be used either as a grain ration or a roughage ration for horses and cattle. The use of the crop for silage is increasing. The grain is also used as food for man.

FEED FOR STOCK.

Milo is fed to horses, cattle, sheep, hogs, and poultry much the same as corn is fed. Milo may be fed in the bundle as a roughage ration or the heads may be fed separately as a grain ration. The grain should be cracked or ground coarsely before it is fed to horses, cattle, or hogs. Cracked grain digests more readily than whole grain and gives better results, as grain grown in dry climates is usually very hard and is not readily crushed by live stock. Therefore much of it may pass through the animals whole if it is not cracked before feeding. The whole heads may be ground without first thrashing, or the grain alone may be cracked. The former is known commercially as head chops and the latter as milo chops. Milo is used quite extensively in combination with other grains in the manufacture of poultry or chick feeds.

Milo does not form a balanced ration. For best results it should be supplemented with other feeds rich in protein, such as alfalfa, clover, or other leguminous hay, or cottonseed meal or cake.

FOOD FOR MAN.

For many years milo has been used to a limited extent for human food. In recent years scientific experiments have been conducted to determine the value of milo in the human diet. The results of these experiments show that milo meal is about equal to corn meal. It can be used alone for batter cakes and muffins or it can be mixed with wheat flour in varying proportions in the same way that corn meal is used for making loaf bread.

DISEASES AND INSECT ENEMIES.**DISEASES.**

Milo differs from most other varieties of sorghum in that so far as known it is immune to kernel smut. This is an important characteristic, because there is no loss to the crop from that source. Kernel smut is quite common among susceptible sorghum varieties and causes heavy losses if not kept under control. No disease seriously affects milo.

INSECT ENEMIES.¹

The insect enemies of milo are few and seldom cause serious trouble. In some localities and under certain conditions chinch bugs do considerable damage to the young plants. Aphids or plant lice sometimes accumulate in great numbers on the leaves and soft portions of the young plants of milo, as they do on all other sorghums, and tend to stunt them by sucking the juices. The fall army worm may cause damage to the plants by tunneling through the tightly coiled leaves, causing a series of round holes which show when the leaves unfold, or they may tunnel in the stem, particularly near the heads. This weakens the leaves and stem and high winds break them off. The sorghum midge causes sterility at low altitudes and especially under humid conditions, as in all other sorghums, by laying its eggs in the flowers. The larvæ prevent seed production by absorbing the juices from the young ovary, so that the kernel never develops. Damage by the midge in the San Antonio district of Texas and under similar conditions largely may be prevented by the early seeding of early varieties, as the crop then comes into flower before the midge appears in large numbers. It is possible that this freedom from injury may be due to parasites which hold the midge in check in the early part of the season.

¹ This account of the insect enemies of milo has been approved by the Bureau of Entomology.

PUBLICATIONS ON GRAIN SORGHUMS.

In the list that follows, those publications to which no price is attached may be obtained without charge upon application to the Secretary of Agriculture; publications having a price attached may be obtained only by remitting the sum stated to the Superintendent of Documents, Government Printing Office, Washington, D. C.

FARMERS' BULLETINS.

- Better Grain-Sorghum Crops. (Farmers' Bulletin 448.) Price, 5 cents.
Kafir as a Grain Crop. (Farmers' Bulletin 552.)
Use of Corn, Kafir, and Cowpeas in the Home. (Farmers' Bulletin 559.)
The Feeding of Grain Sorghums to Live Stock. (Farmers' Bulletin 724.)
Cereal Crops in the Panhandle of Texas. (Farmers' Bulletin 738.)
Shallu, or "Egyptian Wheat." (Farmers' Bulletin 827.)
Growing Grain Sorghums in the San Antonio District of Texas. (Farmers' Bulletin 965.)
How to Use Sorghum Grain. (Farmers' Bulletin 972.)

DEPARTMENT BULLETINS.

- Corn, Milo, and Kafir in the Southern Great Plains Area: Relation of Cultural Methods to Production. (Department Bulletin 242.)
Crop Production in the Great Plains Area. (Department Bulletin 268.)
Studies on the Digestibility of the Grain Sorghums. (Department Bulletin 470.)
Grain-Sorghum Experiments in the Panhandle of Texas. (Department Bulletin 698.)

BUREAU OF PLANT INDUSTRY CIRCULARS.

- Feterita, a New Variety of Sorghum. (Bureau of Plant Industry Circular 122-C.) Price 5 cents.
Three Much-Misrepresented Sorghums. (Bureau of Plant Industry Circular 50.) Price, 5 cents.

BUREAU OF PLANT INDUSTRY BULLETINS.

- The History and Distribution of Sorghum. (Bureau of Plant Industry Bulletin 175.) Price, 10 cents.
The Importance and Improvement of the Grain Sorghums. (Bureau of Plant Industry Bulletin 203.) Price, 10 cents.
Grain-Sorghum Production in the San Antonio Region of Texas. (Bureau of Plant Industry Bulletin 237.) Price, 5 cents.
The Kaoliangs: A New Group of Grain Sorghums. (Bureau of Plant Industry Bulletin 253.) Price, 15 cents.



FARMERS' BULLETIN 1148
UNITED STATES DEPARTMENT OF AGRICULTURE

COWPEAS

CULTURE AND VARIETIES



THE COWPEA is the best known and most extensively grown leguminous crop in the Southern States. It is grown mainly for forage and to improve the soil, but the seeds are rather commonly used for human food.

The cowpea is of the greatest value in the cotton belt, although it can be grown profitably much farther north.

The cowpea will do best on sandy loams, but will succeed on practically all types of well-drained soil.

To obtain the best results with cowpeas, poor or unproductive soils should be fertilized with about 300 pounds of acid phosphate and 50 pounds of potash to the acre.

The most valuable varieties are the Whippoorwill, Groit, New Era, and Brabham for seed or hay and the Blackeye or the White for table use.

The cowpea should not be sown before corn-planting time, and usually it is better to wait until at least two weeks later.

For seed production the best practice is to sow in rows 3 feet apart, while for forage or soil improvement broadcasting is most generally practiced.

Cowpeas grown in combination with other crops, such as sorghum, Sudan grass, Johnson grass, and millet, produce a larger yield of hay, which is more easily handled and cured than cowpeas grown alone and constitutes a better balanced ration.

The cowpea succeeds under such a wide range of conditions that it can be used to good advantage in almost any system of rotation.

Root-knot and wilt, the two diseases most serious to the cowpea in the United States, may be controlled largely by growing such resistant varieties as the Iron, Brabham, and Victor and by rotating with crops not affected.

The most serious insect enemies of the cowpea are the cowpea weevil and the 4-spotted bean weevil, both of which cause considerable damage to the seed. These weevils may be easily controlled if proper methods are employed in caring for the seed.

As a summer annual the cowpea is brought more or less into competition with velvet beans and soy beans. In the regions adapted to these crops the cowpea succeeds for general purposes under a greater diversity of conditions.

Contribution from the Bureau of Plant Industry

WM. A. TAYLOR, Chief

Washington, D. C.

September, 1920

COWPEAS: CULTURE AND VARIETIES.

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HISTORY OF THE COWPEA.

THE COWPEA¹ (fig. 1) is undoubtedly a native of Central Africa. A wild plant differing little from the cultivated cowpea occurs throughout much of that continent.² Hybrids of this wild plant and the cultivated cowpea are readily obtained. The cultivated cowpea consists of three main groups—the asparagus bean,³ the catjang,⁴ and the cowpea,¹ each of which represents a group of varieties having much in common but connected through intermediate varieties. The cowpea is the most important of the three groups.

The large number and great diversity of cultivated varieties throughout Africa and over the southern half of Asia and the adjacent islands as well as the Mediterranean region of Europe indicate that the cowpea is of ancient cultivation for human food. It was early introduced in the Spanish settlements in the West Indies and was grown in North Carolina in 1714, probably coming from the West Indies. Its culture in Virginia was reported about 1775 and no doubt was quite general in the United States early in the nineteenth century.

Without doubt, the cowpea is the *Phaseolus* mentioned by the old Roman writers. In Italy the Blackeye cowpea is still called by the

¹ *Vigna sinensis*.

² Piper, C. V. The wild prototype of the cowpea. In U. S. Dept. Agr., Bur. of Plant Indus. Circ. 124, p. 29–32. 1913.

³ *Vigna sinensis* var. *sesquipedalis*.

⁴ *Vigna sinensis* var. *cylindrica*.

same name as the kidney bean, namely, "fagiolo," which is the Italian equivalent of *Phaseolus*. In East Africa both the wild and cultivated cowpeas are called "kunde," while in India, where the catjang is more extensively cultivated, the name "lubia," with many others, is used. In America the cowpea was first known as "callivance" and



FIG. 1.—Cowpea plant (*Vigna sinensis*), showing mature pods.

later as "Indian pea," "southern pea," "southern field pea," and "cornfield pea." The first published record of the name cowpea was in 1798 and applied apparently to a single variety.⁵

The cowpea at present is the best known and most extensively grown leguminous crop in the Southern States, but it can be grown profitably much farther North. Although it succeeds under a greater diversity of climatic, soil, and cultural conditions than most other legumes, the best results are obtained in forage, soil improvement, and seed production by a thorough understanding of the requirements and the best varieties of the crop.

CLIMATIC ADAPTATIONS.

The cowpea is a warm-weather crop; therefore it has the greatest value in the Southern States, gradually lessening northward. (Fig. 2.) It is grown successfully, however, in the southern parts of Ohio, Illinois, Indiana, and New Jersey, and in parts of Michigan. In gen-

⁵ The writings of Thomas Jefferson, Monticello edition, v. 10, p. 12. Washington, D. C. 1904.

eral, the cowpea is adapted to about the same climatic conditions as corn, but it requires somewhat more heat. It will withstand a considerable degree of drought; but under very dry conditions will produce only a moderate quantity of hay and a very small number of seeds, if any. Both in spring and in fall the leaves are injured by the least touch of frost, and a heavy frost is always fatal. The cowpea withstands moderate shade sufficiently well to be valuable in orchards. In heavy shade the plants are usually much attacked by mildew.

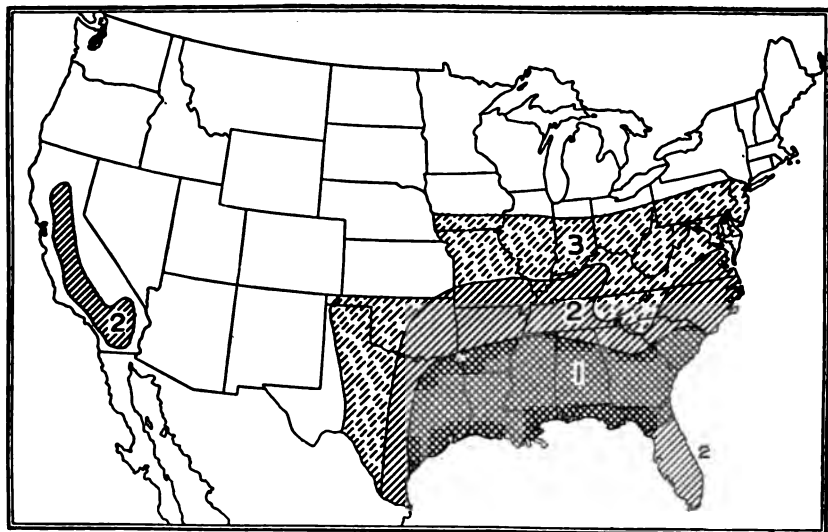


FIG. 2.—Outline map of the United States, showing the comparative distribution of cowpeas. 1, Area in which cowpeas are grown most extensively; 2, area in which cowpeas are grown quite generally; 3, area in which cowpeas are grown to some extent.

SOIL RELATIONS.

The cowpea succeeds on practically all types of soil. It does apparently quite as well on sandy soils as on heavy clays, but will do better than clover or alfalfa on thin soils or soils that are poor in lime. No other legume can be grown so successfully and on such a variety of soils under adverse conditions as the cowpea. A very rich soil is not conducive to the best results with this crop. On such a soil an abundant vine growth is produced, while the yield of grain is small. Poor soils will produce little growth of vine, but will generally yield a good proportion of seed. Clay soils will not produce a heavy yield the first year, but the crop will succeed much better the second season. It may be said that the cowpea will do best on good corn land, but will thrive on all types of soil that are well drained, properly inoculated, and moderately rich.

VARIETIES.

In the selection of a cowpea variety the characters most desirable both for forage and for seed need to be considered. The variety should be suited to local conditions and to the purpose for which the crop is grown. The characteristics most important in considering the cowpea for forage are (1) size and vigor; (2) habit, especially erectness; (3) prolificacy, the pods being well filled and held well

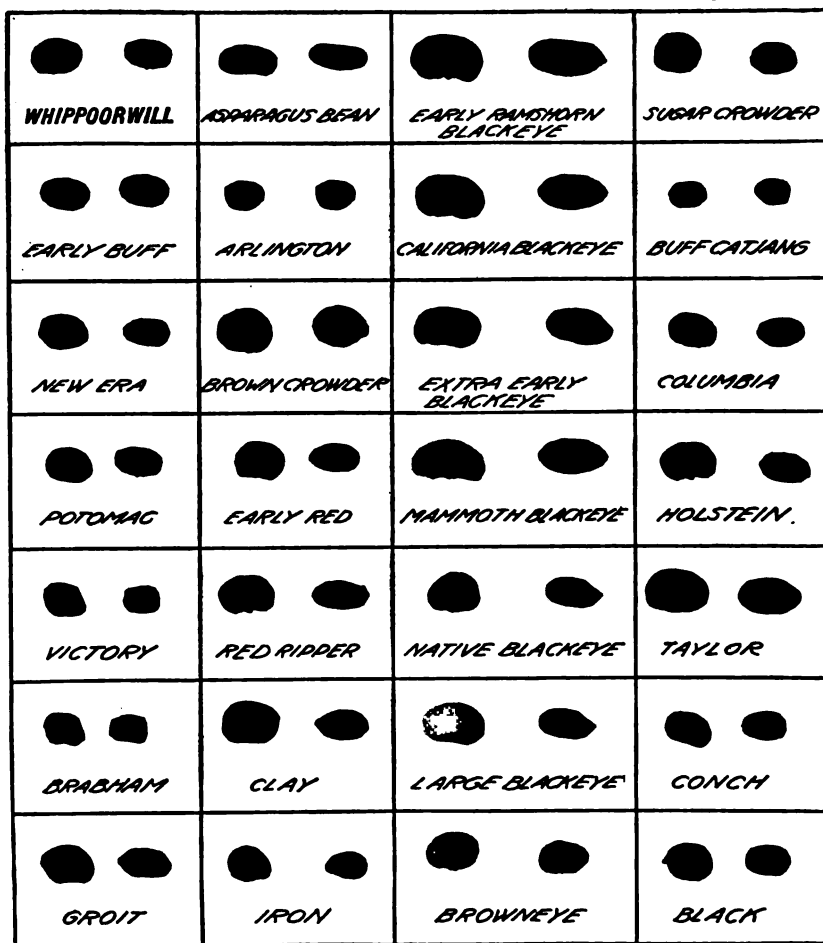


FIG. 3.—Seeds of the most important varieties of cowpeas.

above the ground; (4) disease resistance; (5) ability to retain leaves late in season; (6) time of maturity; and (7) evenness of maturity. Toward the northern part of the cowpea region early maturity is desirable. For planting in corn or sorghum a strong viny habit is of importance. When grown for human food or to be pastured, the yield of pods and seeds needs special consideration.

Most varieties of cowpeas under different conditions of soil or climate exhibit marked fluctuations. On rich soil or when planted early the general tendency is to produce a large growth of vine and but few pods. Usually moist seasons have the same effect. On poor land, especially sandy soils, or when sown late, the plants tend to produce much more seed but less herbage. Moderate drought has a very similar effect, but very severe drought prevents most varieties from producing pods.

At present about 15 varieties (fig. 3) of cowpeas are in common cultivation, while the varieties grown in a small way number, perhaps, about three times as many more. Owing to the fact that the seed is still largely hand picked, the tendency is for the variety which was first introduced in a locality to persist; therefore varieties of relative inferiority are still too largely grown. The varieties are distinguished most readily by the color and size of the seed, although they also differ in habit, length of growing period, yield of seed, and disease resistance.

The most valuable American varieties of cowpeas for forage are the Whippoorwill, Iron, and New Era and their hybrids, the Brabham and Groit. Important, but of secondary value, are such indefinite groups of varieties as the Unknown, Clay, Red Ripper, and Black. A large number of others are grown to a small extent. For table use, the white-seeded varieties, such as the Conch and Cream, and the Blackeye sorts, California Blackeye and Extra Early Blackeye, are preferable.

DESCRIPTIONS OF NEW OR IMPORTANT VARIETIES AND GROUPS OF VARIETIES.

Whippoorwill.—The Whippoorwill, also known as Shinney and Speckled, is one of the old standard sorts and the one most commonly grown. It is a good general-purpose variety and suitable for grain or hay production. Plants tall, suberect, half bushy, prolific; pods held high, the first maturing in about 85 days; seeds buff, marbled with brown.

New Era.—The New Era is one of the important commercial varieties of cowpeas. It is especially valuable on account of its earliness, its erectness, and the smallness of the seed. It usually produces a heavier yield of seed than the Whippoorwill. Plants tall, erect, half bushy, very prolific; pods held high, the first maturing in about 75 days; seeds buff, thickly and evenly speckled with blue.

Groit.—The Groit cowpea is a natural cross between the New Era and Whippoorwill varieties. It has been much confused with the New Era, but in general is from 20 to 25 per cent better and is largely replacing it. Plants suberect, half bushy, very prolific; pods held high, the first maturing in about 80 days; seeds with a ground color

of buff, marbled with brown and thickly sprinkled with minute blue specks.

Brabham.—The Brabham cowpea originated as a natural cross between the Iron and Whippoorwill varieties. It has the tall habit and prolificacy of the Whippoorwill with the resistance to wilt and root-knot of the Iron variety. The Brabham is especially adapted to the sandy soils of the South where wilt and root-knot prevail. Plants tall, half bushy, very prolific; pods held high, the first maturing in about 90 days; seeds buff, marbled with brown.

Iron.—The Iron variety is especially valuable on account of its immunity to root-knot and wilt and is largely grown where these diseases prevail. The Iron is not a heavy yielder of seed. It has harder seed, volunteers more readily, and retains its vitality better than other sorts. Plants tall, half bushy, moderately prolific; pods held medium high, the first maturing in 90 to 100 days; seeds cream buff to vinaceous buff.

Victor.—The Victor is an artificial cross between the Brabham and Groit varieties originated by the United States Department of Agriculture. It has the tall habit of the Brabham and has given better results in yields of hay and seed than either parent. It is valuable for both forage and seed, especially in the Piedmont and Coastal Plain areas of the cowpea region. Its resistance to wilt and nematode attacks is as high as that of the Iron and Brabham varieties. Plants tall, half bushy, very prolific; pods held high, the first maturing in about 90 days; seeds small, of the Brabham shape, buff, marbled with brown, and sprinkled with minute blue specks.

Arlington.—The Arlington cowpea is a cross originated by the United States Department of Agriculture. It is suberect, bushy, very prolific, and adapted to about the same region as the Groit variety; pods held high, the first maturing in about 80 days; seeds white, with a Whippoorwill eye.

Columbia.—The Columbia cowpea is an artificial cross between a blackeye variety and the Red Whippoorwill, originated by the United States Department of Agriculture. This variety is adapted to about the same regions and conditions as the Groit and is of about the same value in habit, forage, and seed yield. Plants suberect, half bushy, very prolific; pods held high, the first maturing in about 85 days; seeds white, with a maroon eye.

Taylor.—The Taylor variety, known in various localities as the Gray Goose, Gray Crowder, Whittle, and Speckled Java, has the largest seeds of all cowpeas handled by growers and seedsmen in this country. In many sections the Taylor is considered a valuable variety, but in general its habit of growth is low and the pods are held so near the ground that it is practically impossible to harvest them with a mower. Plants low, half bushy, prolific; pods held low, the first

maturing in about 90 days; seeds buff, thickly speckled with blue, the blue specks arranged in groups.

Early Buff.—The Early Buff cowpea is one of the earliest and one which has proved to be valuable in the northern part of the cowpea region. Plants suberect, bushy, very prolific; pods held medium high, the first maturing in about 60 days; seeds buff or pinkish buff.

Michigan Favorite.—The Michigan Favorite variety, known also as the New Revenue and Revenue, has been grown, on account of its earliness, to a considerable extent in Illinois, Indiana, and Michigan. It is also grown for table use to some extent southward, especially in Texas. Plants low, half bushy, prolific; pods held low, the first maturing in about 85 days; seeds buff-pink, Crowder form.

Early Red.—The Early Red is a good medium-early variety adapted to about the same region as the Early Buff. Plants half bushy, prolific; pods held medium low, the first maturing in about 75 days; seeds pale red.

Clay.—The term Clay is applied commercially to a group of medium-late varieties with buff-colored seed rather than to any one sort. The Iron cowpea is not included in the Clay group. There are many buff-seeded varieties, all of which have practically the same habit of growth, but they differ slightly in time of maturity, size, and form of seeds. Those sorts which mature their first pods in about 110 days or less make up most of the seed sold as Clay, while the sorts requiring 110 days or more to mature the first pods are called Wonderful or Unknown. On account of its large vigorous growth, the Clay group, especially the Unknown or Wonderful, is grown to a considerable extent for forage and soil improvement.

Red Ripper.—Red Ripper is a group name, like Clay, which is applied to all varieties with maroon seeds rather than to any one sort. Practically all of this group have much the same habit, differing mainly in earliness and seed characteristics. None of them are especially valuable, though in a few sections of the South they are grown for soil improvement and forage.

Black.—The term Black is a group name, including many similar black-seeded sorts which are rather commonly cultivated and succeed well under a wide diversity of conditions. For field purposes the varieties of this group are rather too viny and bear the pods too near the ground to harvest satisfactorily with a mower. If grown in corn they are excellent, and in some sections they are used for pasturing with hogs, as the seeds do not decay readily. In North Carolina, Arkansas, and southward the seeds are said to volunteer freely. A variety quite often grown as Black, Congo, or Early Black differs from the ordinary black sorts in being about 10 days earlier and having larger seeds.

Catjang.—The catjang, or Hindu cowpea (fig. 4), as it is sometimes called, is a group of cowpeas with erect half-bushy plants, small hard seeds, usually oblong or cylindrical, but slightly kidney shaped, and small pods 3 to 5 inches long, which are erect or ascending when green, remaining so when dry, or at length becoming spreading or even deflexed. The most vigorous and best of this group, unfortunately, are very late, and under American conditions at least are not very prolific. The Buff catjang is one of the best early sorts and has given favorable results in some sections of the Southern States.



FIG. 4.—Catjang or Hindu cowpea plant, showing the mature pods.

Blackeye.—The Blackeye varieties are quite numerous and are very similar to each other, the name applying in general to all white sorts with a black eye. The varieties of this group have been grown as a table vegetable since ancient times. In some cases varieties of this group can be satisfactorily identified. One of the earliest forms is the Extra Early Blackeye, a sort adapted to the northern part of the cowpea region. The California Blackeye is grown quite extensively throughout the interior valleys of California.

White.—In this group of varieties the entire seed is creamy white except the sides of the seed scar or hilum and iris, which are sometimes greenish. All white varieties are very similar as to seed characters and are valued principally for table use, being only of secondary

value for forage. Among the sorts commonly grown as distinct varieties are the Conch and the Cream.

Asparagus bean.—The asparagus or yardlong bean (fig. 5) is a group of cowpeas with procumbent, very viny plants, very long (1 to 3 feet), inflated soft pods, and elongated kidney-shaped seed. Varieties of this group have long been used, especially in China and some European countries, as a snap bean, the young pods having an agreeable asparaguslike flavor. None of these beans can compare with the better varieties of the cowpea in production either of seed



FIG. 5.—Asparagus or yardlong bean plant, showing the pods.

or of forage. For the best results the asparagus bean requires the same sort of culture as ordinary pole beans. As a table bean, there is a place for the better varieties of this group. During the past few years, seed of a variety of this bean under the name Shahon pea has been sold at exorbitant prices.

FERTILIZERS.

Soils that are naturally unproductive or badly run down by continuous cropping should be properly fertilized in order to obtain the best results with cowpeas. Nitrogenous fertilizers on soils of good or moderate productiveness have little effect on either the yield or

the protein content of cowpeas. For the best results on very poor soils, however, 40 to 50 pounds of nitrate of soda to the acre or its equivalent in any other nitrogenous fertilizer should be applied. Phosphoric acid and potash in combination, or either alone, generally give a substantial increase in the yield of peas or forage. On soils in need of fertilizer, about 300 pounds of acid phosphate and about 50 pounds of potash to the acre should be applied when preparing the seed bed. As with most other legumes, lime has been found almost invariably to increase the yield of cowpeas. However, the cowpea is not benefited to the same extent by the use of lime as are red clover, alfalfa, and many other legumes.

PREPARATION OF THE SEED BED.

The cowpea will give fair results upon a poorly prepared seed bed, but the best results are to be obtained when the soil receives as careful preparation as for corn. Even if the crop is sown late in the spring, it is often desirable to plow the ground early and harrow the field at intervals to destroy weeds and to maintain a soil mulch to receive and retain the moisture. When sown as a catch crop after wheat or other small grains, if the land is clean and mellow, the seed bed may be prepared with a disk harrow or seeded with a single-disk drill without previous preparation.

INOCULATION.

Like other legumes, the cowpea is able to utilize the nitrogen of the air through the action of bacteria which live on the roots of the plant. If the cowpea has been grown in a locality for many years, the bacteria are plentiful and inoculation is not necessary. This is quite true throughout the Southern States. In new regions, however, especially in the North and West, when cowpeas are being grown for the first time, the soil should be inoculated from an outside source. Successful inoculation is shown by the development of nodules or tubercles on the roots (fig. 6) and may be secured by using a pure culture of the proper bacteria, a limited quantity of which may be obtained from the United States Department of Agriculture free of charge, or by dusting the cowpea seed with soil obtained from an old cowpea field known to have been inoculated, using about a gallon of soil to a bushel of seed. Inoculation experiments conducted by the Michigan Agricultural Experiment Station,⁶ showed that cowpeas with root nodules contained 47 per cent more protein than those without nodules.

⁶ Smith, C. D., and Robison, F. W. Observations on the influence of nodules on the roots upon the composition of soy beans and cowpeas. Mich. Agr. Exp. Sta. Bul. 224, p. 127-132. 1905.

TIME OF SOWING.

Cowpeas should not be sown until the soil has become thoroughly warmed and all danger of cold weather is past. After that time they can be sown whenever moisture conditions are favorable. When



FIG. 6.—Roots of a cowpea plant, showing the development of nodules.

sown in cold, wet soil, cowpea seed will either rot or give a poor stand of unhealthy plants. The latest date for profitable sowing, however, is at least 90 days before the first killing frost.

The time of sowing will depend largely upon the purpose for which the crop is grown. If grown for seed or hay, the seed should be

sown shortly after the corn crop. For green manuring, pasturage, or hay, cowpeas sown as late as the first of August in the South will make considerable growth. When cowpeas are to follow wheat or oats, they should be sown at the earliest possible moment after the crop is cut. The yield of forage and seed from the Groit variety, sown on different dates at Arlington Farm, Va., and Rocky Mount, N. C., and the New Era variety at Manhattan, Kans., is shown in Table I.

TABLE I.—Yields per acre of the Groit and New Era varieties of cowpeas in time-of-sowing tests.

Groit variety.					New Era variety.		
Date sown.	Arlington Farm, Va.		Rocky Mount, N. C. ¹		Date sown.	Manhattan, Kans. ²	
	Hay.	Seed.	Hay.	Seed.		Hay.	Seed.
	<i>Tons.</i>	<i>Bushels.</i>	<i>Tons.</i>	<i>Bushels.</i>		<i>Tons.</i>	<i>Bushels.</i>
May 1.....	1.39	28	0.74	12.8	May 12.....	1.19	7.16
May 15.....	1.55	28	.94	16.0	May 19.....	2.00	10.32
June 1.....	1.58	29	1.09	17.1	May 26.....	2.00	9.91
June 15.....	1.80	19	1.17	14.3	June 3.....	2.26	10.68
July 1.....	1.74	12	1.25	15.4	June 9.....	2.08	11.59
July 15.....	1.10	5	.84	13.3	June 16.....	1.77	5.96
Aug. 1.....	.41	2	.....	.....	June 28.....	1.10	4.47

¹ Herman, V. R. Soy beans and cowpeas for North Carolina. N. C. Agr. Exp. Sta. Bul. 241, 40 p., 9 fig. 1919.

² Ten Eyck, A. M., and Call, L. E. Cowpeas. Kans. Agr. Exp. Sta. Bul. 160, p. 179-209, illus. 1909.

METHOD AND RATE OF SOWING.

The best method for the production of seed is to sow in rows about 3 feet apart, with the seeds from 2 to 3 inches apart in the row. Although a corn planter may be used for sowing in this way, the most practical method is to use the ordinary grain drill, stopping part of the grain cups so as to leave the rows about 3 feet apart and setting the drill the same as when sowing about 2 bushels of wheat to the acre.

When cowpeas are grown for forage or green manuring the seeds are sown broadcast or in drill rows 6 to 8 inches apart. (Fig. 7.) The grain drill set to sow about $1\frac{1}{2}$ bushels of wheat to the acre will be found most satisfactory. If grown for silage with corn, the corn and cowpeas can be sown in one operation, using the ordinary corn planter. If cowpeas are sown in corn at the last cultivation, the common practice is to sow the seeds broadcast at the rate of 1 to $1\frac{1}{2}$ bushels to the acre and cover them with a cultivator. (Fig. 8.) Another method is to sow with a 1-horse wheat drill at the rate of about 45 pounds to the acre, sowing two or three rows of cowpeas between the rows of corn. Cowpeas and corn are sometimes sown thickly together for hay with excellent results, using about one-half to 1

bushel of corn and 1 bushel of cowpeas to the acre. However, when corn makes a very heavy growth cowpeas will not give very good results on account of the shade and lack of moisture.

The quantity of seed to be sown to the acre varies according to the method of sowing. With rows 24 to 40 inches apart, about 30 to 40 pounds of seed to the acre will be required. When sown broadcast for hay, green manuring, or soiling, about 90 pounds of seed to the acre will be ample.



FIG. 7.—A field of cowpeas sown broadcast for hay.

Table II gives the average of method-of-culture tests covering three years at Arlington Farm, Va., with standard varieties in which the broadcasted plats were sown at the rate of 90 pounds, the 18-inch rows at the rate of 45 pounds, and the 40-inch rows at the rate of 30 pounds to the acre.

TABLE II.—Average yields to the acre in method-of-culture tests with cowpeas at Arlington Farm, Va.

Variety and method of culture.	Hay.	Seed.	Variety and method of culture.	Hay.	Seed.
	<i>Tons.</i>	<i>Bushels.</i>		<i>Tons.</i>	<i>Bushels.</i>
Early Buff:			Brabham:		
Broadcast.....	1.32	10.7	Broadcast.....	1.83	3.9
18-inch rows.....	1.32	13.3	18-inch rows.....	1.90	14.6
40-inch rows.....	1.18	15.9	40-inch rows.....	1.66	16.0
Whippoorwill:			New Era:		
Broadcast.....	1.98	4.5	Broadcast.....		
18-inch rows.....	1.90	6.6	18-inch rows.....	1.52	16.4
40-inch rows.....	1.84	9.9	40-inch rows.....	1.26	15.3

CULTIVATION.

Under proper soil conditions cowpeas will germinate quickly and cultivation may begin early. When the seedlings first appear above the ground they are very tender and are easily broken, so that care must be exercised in working them. Usually the crop may be cultivated in two or three weeks after sowing. Ground sown to cowpeas is sometimes packed by heavy rains soon after sowing. A harrow or weeder can then be used advantageously to break the crust unless the seeds have germinated, when much damage may



FIG. 8.—Cowpeas grown with corn. Cowpeas are quite generally sown at the last cultivation of the corn for soil-improvement purposes.

result from harrowing. When sown in rows the ordinary implements used in corn cultivation will be found satisfactory, as the culture of cowpeas is essentially the same as for corn. About three cultivations at intervals up to the time the blossoms appear will usually be sufficient. If the ground is well cultivated and cleaned of weeds previous to sowing, broadcast sowings under favorable weather conditions grow rapidly and will smother any weeds which may start after sowing.

COWPEAS IN ROTATIONS.

Rotation of crops is one of the most important methods employed for maintaining or increasing yields of subsequent crops. The need for systematic rotations is quite apparent on most types of soil in

the cowpea region. It is a general rule that some leguminous crop, such as cowpeas, soy beans, alfalfa, or some of the clovers, should be included in all systems of rotation. The place of the cowpea in the rotation will depend largely on whether the crop is to be plowed under as a green manure or to be harvested for grain or hay. In one case it is sown as a catch crop after small grains and in the other in the spring as a regular crop. The cowpea succeeds under so many different conditions that it is especially valuable as a catch crop and for hay or seed production in almost any system of rotation.

A system of cropping practiced quite generally throughout the cotton belt allows the largest possible area to cotton, three years being given to this crop, the fourth year to corn and cowpeas, and then three years again to cotton. On the poorer soils of this region better results are obtained by growing cotton two years and corn and cowpeas the third year. In the sugar-cane districts of Louisiana excellent results are obtained by taking three crops of cane off the land and sowing to cowpeas or corn and cowpeas the fourth year.

In many sections of Missouri, Arkansas, and Tennessee a rotation of wheat or oats and cowpeas has given good results. On farms where live stock is kept the following rotation is very popular: First year, cotton; second year, corn, with cowpeas at the last cultivation; third year, winter oats or wheat, with a catch crop of cowpeas for hay or seed after the grain has been removed.

On the Black Lands of Texas one of the most successful rotations is: First year, wheat or oats; second year, cowpeas; third year, corn, milo, or sorghum; fourth year, cotton. The following rotations are recommended by the Oklahoma Agricultural Experiment Station:

No. 1.—First year, cotton; second year, cowpeas; third year, kafir or corn.

No. 2.—First year, corn; second year, cowpeas; third year, wheat or oats.

No. 3.—First year, cotton; second year, cowpeas; third year, oats or wheat.

No. 4.—First year, kafir; second year, cowpeas; third year, wheat or oats.

In those sections devoted to growing tobacco, the Virginia Agricultural Experiment Station recommends the following 7-year rotation: Tobacco, wheat, grass, grass, corn with crimson clover as a cover crop, cowpeas, and red clover. A good rotation in the corn belt on land where corn and wheat or oats are regularly grown consists of corn, soy beans, wheat, and clover, with cowpeas for hay when clover fails. Cowpeas are also to be recommended as a crop to precede alfalfa. The seed should be sown on land prepared the previous fall, as early in the spring as conditions permit. The cowpeas are cut for hay in July, after which the land can be prepared for alfalfa seeding in the fall.

COWPEAS IN MIXTURES.

Although the cowpea can be satisfactorily grown alone, it is more advantageously grown for hay in combination with other crops. When grown in this manner, not only is a greater variety and larger yield of feed obtained, but the mixed hay is much more easily cured and handled. Corn is used quite generally with cowpeas, but only to a slight extent for hay. The crop most widely used with cowpeas for hay is sorghum, both sweet sorghums and kafirs, although other crops, such as Sudan grass, Johnson grass, soy beans, and millet, are used.

COWPEAS AND CORN.

The cowpea is an excellent crop to grow with corn for silage, and it is being used extensively for this purpose on many dairy farms, especially in the northern part of the cowpea area.

If grown with corn for other than silage purposes, cowpeas are allowed to ripen a fair percentage of pods, which are gathered for seed and the remainder pastured. This method not only gives a crop of corn but also sufficient cowpea seed for sowing the next season, and the residue makes either a hay crop or a fair amount of grazing for stock. In many parts of the South, especially in the sugar-cane districts of Louisiana, cowpeas instead of being pastured are harvested for hay after the corn has been gathered.

COWPEAS AND SORGHUM.

Cowpeas grown in combination with sorghum make an excellent hay or silage crop (fig. 9). As a hay crop this mixture is more easily cured than cowpeas alone, constitutes a well-balanced ration, and is relished by all kinds of farm stock. Both the sweet sorghums and the kafirs are used. The Amber sorghum is most generally favored, especially in the Piedmont region of the South, while the kafirs are grown in the Southwest. When grown in rows, the Sumac and Orange varieties of sorghum are fully as good as the Amber, as they grow larger and stronger plants. The Whippoorwill, Iron, Unknown, and Clay varieties of cowpea require about the same time to mature as the sorghums and therefore should be used in place of the earlier sorts. In general, the planting should be from July 1 to 15. Harvesting with a mowing machine is most satisfactory.

When sown "broadcast" for hay, the sowing is best done with a grain drill on well-prepared land, the two kinds of seed being well mixed and sown at the same time. Usually the best rate to sow is about 1 bushel of cowpeas and half a bushel of sorghum seed to the acre. Where the grain drill is not available for sowing, the cowpea seed should be disked or harrowed in, and the sorghum should then

be sown while the land is rough, the seed being covered with a drag harrow or weeder.

Excellent results are obtained by sowing cowpeas and sorghums together in cultivated rows $2\frac{1}{2}$ to 3 feet apart. This method requires about 45 pounds of cowpeas and about one-third of a bushel of sorghum seed to the acre.

If Johnson grass is not a pest or if it is well established on a field and there is no desire to eradicate it, it can be used very advantageously to form a part of a mixture with cowpeas. (Fig. 10.) Little



FIG. 9.—Cowpeas grown with sorghum. This makes an excellent hay mixture or may be used for ensilage purposes.

• COWPEAS AND JOHNSON GRASS.

trouble will be encountered in killing Johnson grass north of Tennessee and central Virginia, but south of these States the difficulty is much greater. Wherever Johnson grass and cowpeas are used, excellent results are obtained, both in the yield and in the quality of hay produced.

This mixture should be sown at the rate of about 1 bushel of Johnson grass and 1 bushel of cowpeas to the acre. If sown with a grain drill, care must be taken to see that the Johnson grass seed is not covered too deeply. Where the grass is already established, the land may be either plowed or thoroughly disked in late spring, the treatment depending largely on the nature of the soil. The cowpeas in this case are sown alone in June. Usually about $1\frac{1}{2}$ bushels of cowpea

seed are required, as the Johnson grass makes a much more vigorous growth from the rootstocks than when grown from seed.

COWPEAS AND SUDAN GRASS.

Sudan grass is an excellent crop for growing in combination with cowpeas for hay, being easily harvested and cured. It can be used without fear of its becoming a troublesome weed in those areas where Johnson grass is considered a pest. The best results are obtained by broadcast sowing, using about 50 pounds of cowpeas and 10 pounds of Sudan grass to the acre. The mixture is cut for hay about the time the cowpeas are ready for hay.

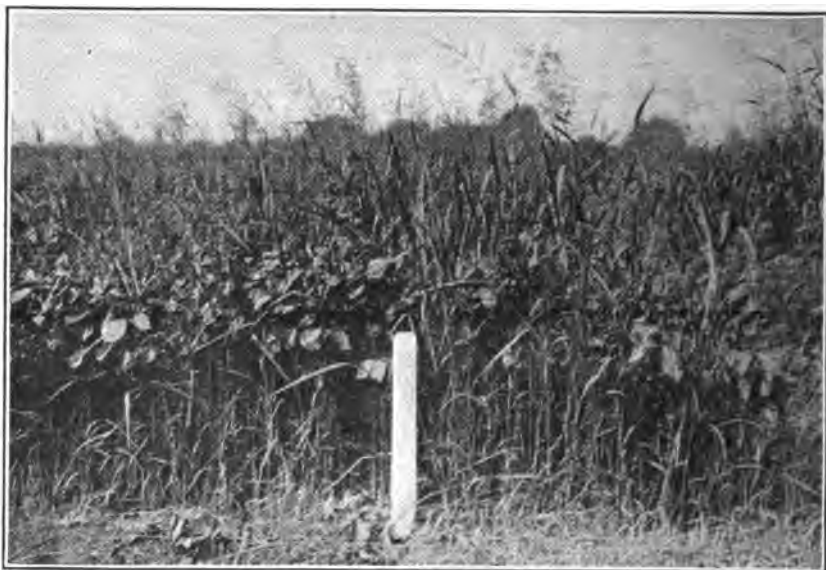


FIG. 10.—Cowpeas and Johnson grass combined for a hay mixture.

COWPEAS AND MILLET.

German, or Golden, millet is sometimes grown in mixture with cowpeas. The millet aids to a considerable extent in curing the hay and improves the quality by adding variety. As millet requires only a short time to mature, early varieties of cowpeas, such as the New Era, are most suitable for combining with it. With late and rank-growing varieties of cowpeas the results will not be satisfactory, as the millet matures early and is not sufficiently strong to support the vines.

COWPEAS AND SOY BEANS.

Cowpeas and soy beans afford a very satisfactory combination, either for hay or for pasture, and the yield is nearly always greater than that of either crop alone. Only the tall strong-growing varie-

ties of soy beans are desirable, as they assist very materially in supporting the viny cowpeas. Varieties of these crops maturing at about the same time should be selected. The hay of this mixture is of high feeding value, as both plants are rich in protein.

A mixture of soy beans and cowpeas should have more soy-bean plants than cowpeas, so that the cowpea vines may be properly supported. About 1 bushel of soy beans and half a bushel of cowpeas are required if "drilled broadcast," but if sown in rows 3 feet apart about half this quantity of each is sufficient. The sowing, whether broadcast or in cultivated rows, is best done with a grain drill.

In harvesting for hay, the best results are obtained if the mixture is cut when both plants are at the stage of growth when the best quality of hay may be produced. This is when the soy-bean seed is about full grown and the first pods of the cowpeas are mature. The harvesting of a mixture of cowpea and soy-bean hay is easier than a crop of cowpeas alone.

DISEASES OF THE COWPEA.⁷

Root-knot⁸ and wilt⁸ are the most serious diseases of the cowpea in the United States. Both troubles are primarily and most generally found in the sandy soils of the Southern States, and but rarely become serious on the heavier soils. Of the two diseases root-knot is the more general and widespread, and the losses from it are more severe.

Several other troubles of minor importance are white leaf-spot,⁹ red leaf-spot,¹⁰ and mildew.¹¹ These diseases are fairly common and widespread, but do not usually cause appreciable damage to the crop.

ROOT-KNOT.

Cowpea root-knot is the trouble most familiar to the farmer, because of the effect it has on the roots of the diseased plants. Instead of the normal, slender, tapering roots found on healthy plants, those attacked by root-knot have numerous irregular swellings, or galls, over the entire root system. They vary from small inconspicuous swellings to rough knotty enlargements an inch or more in diameter. At first they are the same color as the healthy roots, but they soon turn brown and decay, causing the serious injury or death of the roots. They are quite different from the small roundish nodules of the beneficial nitrogen-gathering organism, which rarely exceeds

⁷ Prepared with the advice and cooperation of W. W. Gilbert, Pathologist, Office of Cotton, Truck and Forage Crop Disease Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.

⁸ Orton, W. A., and Webber, H. J. Some diseases of the cowpea. U. S. Dept. Agr. Bur. Plant Indus. Bul. 17, 38 p., 6 pl. 1902.

⁹ Caused by the fungus *Americosporium oeconomicum*.

¹⁰ Caused by the fungus *Cercospora cruenta*. ¹¹ Caused by the fungus *Erysiphe polygoni*.

one-fourth of an inch in diameter. These nodules are attached loosely to the roots, while the root-knot galls are enlargements of the roots themselves and can not be detached without breaking the roots.

Root-knot is caused by a tiny eelworm, or nematode,¹² which lives for the most part in the roots of cultivated crops. It bores its way into the young roots, secures its food from them, and so irritates the tissues that galls are produced. The formation of the galls not only uses up the food supply, but also interferes with its passage to the plant above and results in stunting or death. If one of the galls is broken open, the enlarged female nematodes can often be seen with the naked eye as pearly-white roundish bodies about the size of a pinhead.

The control of the root-knot is of vital importance in the South, because the cowpea is the principal leguminous crop used in rotations as a soil improver over great areas of country. The planting on infested land of cowpeas susceptible to root-knot not only results in poor crops of cowpeas, but does serious injury to crops susceptible to root-knot that follow by rapidly increasing the number of nematodes in the soil, whereas profitable rotations should be planned for the purpose of reducing this disease. A conspicuous example of the results of this bad practice is the common experience of farmers that cotton wilt is much more serious after a crop of cowpeas which are susceptible to root-knot, the reason being that the nematodes increase rapidly on the cowpeas, attack the cotton, and, by wounding its roots, make it more subject to wilt.

For intelligently planning suitable crop rotations for such root-knot infested fields it is essential to know the crops which may safely be planted, as well as those which should be avoided. Winter grains, corn, sorghum, velvet beans, four varieties of cowpeas (Iron, Brabham, Monetta, and Victor), and one of soy beans (Laredo) are immune to root-knot, while other farm crops for the most part are quite susceptible.¹³

The most effective and practical method of controlling root-knot combines the use of resistant varieties of cowpeas with the other known immune crops in the rotation. Susceptible varieties of cowpeas or other crops should not be planted on infested land until it has been rotated for one to three years with immune crops to starve out the nematodes.

WILT.

Wilt is characterized by a premature yellowing and falling of the leaves and the final death of the plants. The stems become yellow, the plants are stunted, and usually no fruit is set. Diseased stems

¹² *Heterodera radiclecola*.

¹³ For a full description of root-knot and its control, see Bessey, E. A., and Byars, L. P. The control of root-knot. U. S. Dept. Agr., Farmers' Bul. 648, 19 p., 20 fig. 1915.

are brown to black inside. The dead stalks of plants killed by wilt usually turn pink, owing to the presence of masses of the spores of the fungus which causes the disease. Wilt usually begins to make its appearance about midseason, and by August or September the plants in infested areas in the field may all be dead. The disease occurs in spots in the field, which enlarge from season to season until eventually the entire area may be affected. Wilt may be spread from field to field by drainage water, cultivation, animals, or any other agency which will carry some of the diseased soil.

Wilt is caused by a fungus which enters the roots from the soil, grows into and fills up the water-carrying vessels of the stems, and thus stops the passage of food and water to the plant, resulting in its wilting and death.

Wilt may be controlled by using varieties of cowpeas which are immune. Fortunately, the varieties known to be immune to root-knot are also highly resistant to wilt, and on infested land these should be planted to the exclusion of susceptible varieties.

INSECT ENEMIES OF THE COWPEA.¹⁴

The seed of cowpeas is subject to the attack of several species of weevil, the cowpea weevil¹⁵ and the 4-spotted bean weevil¹⁶ causing the most injury. The habits of both species, which are generally distributed throughout the Southern States, are practically identical. The weevil lays its eggs on the pods of the cowpea in the field and continues to breed for successive generations in the stored seed. The food value of the crop is often entirely destroyed or its value for planting purposes seriously impaired or destroyed. The larger seeds that have been attacked by two or three larvæ may germinate and make fairly good growth, although the seeds of smaller varieties may be ruined for planting by a single weevil.

The weevil may be very easily controlled if proper methods are employed in caring for the seed. It is impossible to prevent injury in the field. The best methods of control in the stored seed are the application of heat and fumigation with carbon bisulphid or hydrocyanic acid gas.¹⁷

In fumigating with carbon bisulphid, the seeds are placed in airtight bins or receptacles and fumigated for at least 48 hours, using 1 pound of carbon bisulphid to 100 bushels of seed. The bisulphid is poured in shallow pans set on top of the seed or poured directly upon the seeds. As the carbon bisulphid volatilizes it forms a gas heavier

¹⁴ Prepared with the advice and cooperation of E. A. Back, Entomologist, Stored-Products Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture.

¹⁵ *Bruchus chinensis*.

¹⁶ *Bruchus quadrimaculatus*.

¹⁷ Back, E. A., and Duckett, A. B. Bean and pea weevils. U. S. Dept. Agr., Farmers' Bul. 983, 24 p., 24 fig. 1918.

than air which sinks among the seeds. After fumigation, the seed should be thoroughly aired, as otherwise the germination may be affected. The treatment should be repeated in 10 days or two weeks in order to destroy all forms of the weevil not reached by the first application. In using carbon bisulphid, care must be exercised that it does not come in contact with fire of any kind, because of its high inflammability. Fumigation is not practicable at temperatures lower than 60° F., and is much more effective when the temperature is above 70° F.

Hydrocyanic-acid gas, which is not inflammable under ordinary conditions but most deadly poisonous and dangerous to human life if not carefully handled, is not so generally used.

The heat method, sometimes termed "kiln drying," consists of passing the seed over heated pipes or passing hot air through the mass of seed so as to subject to a temperature of 120° to 140° F.¹⁸ One treatment is sufficient to kill all stages of the weevil, especially if the heat is applied sufficiently long to raise the entire bulk of the seed to at least 120° F. This can be done without injuring the germinating qualities of the seed.

A very simple method which is often employed with small lots consists in soaking the seed for one minute in boiling water. A longer period of time tends to injure the seed for planting. A modification of this remedy consists in placing the seed in cold water and gradually heating to 140° F., when the seed should be at once removed and spread out to dry.

In cold-storage experiments it was found that cowpea seed kept at temperatures as low as 26° to 31° F. for periods ranging from 58 to 184 days gave a germination of 86 to 95 per cent and varied little from the untreated seed kept as a check. The observations showed that when weevils in any of the stages in their life cycle are subjected to a temperature of 32° F. or below they will not mature.

The treatment of seeds which have been thinly and evenly spread on a canvas or floor by spraying with kerosene at the rate of 1 pint to 10 bushels of seed has been found beneficial. For spraying, an atomizer and spray pump or very fine sprinkler may be used, after which the seed should be shoveled so as to bring the treated and untreated seed together until all have an equal coating of the kerosene.

An application of air-slaked lime or road dust has been found very effectual for protecting stored cowpea seed from weevil damage. With 3 bushels or less, the best results were obtained by mixing the seed with an equal weight of slacked lime, while in lots up to 25 bushels 1 part of lime and 2 parts of seed were used. Where quanti-

¹⁸ Chittenden, F. H. The cowpea weevil. U. S. Dept. Agr., Bur. Ent. Bul. 96, pt. 6, p. 84-94, fig. 21, pl. 1. 1912.

ties greater than 25 bushels are to be stored, using 1 part of lime to 8 of cowpeas and then covering the seed with a half-inch layer of lime was found effective. The seed should be kept dry, in order that the lime may not injure the viability. If desired, the seeds can be sifted before planting, while if they are to be used for feed or human food the lime can be easily washed from seeds from which no weevils have emerged. When seeds contain weevil holes before they are placed in the lime, the lime fills the cavity and is removed with great difficulty.

The foliage of cowpeas is more or less subject to attack by various insects, but this damage is seldom serious.

COWPEAS, SOY BEANS, AND VELVET BEANS COMPARED.

Cowpeas, velvet beans, and soy beans are all summer annuals, agriculturally much alike, and for the best results are adapted to nearly the same regions. A comparison of these crops is not so much a matter of determining which is the best crop as it is a careful consideration of their climatic and soil adaptations and the special uses of each on the farm. Among the important points that determine the value of a leguminous crop are its value for forage, both in quantity and quality, either as hay or pasture; its ability to supply additional nitrogen; and the value of the seed as a cash crop or for its utilization on the farm.

The soy bean has about the same climatic adaptations as corn, and therefore its culture is much more extended than that of either the cowpea or velvet bean. The velvet bean is especially adapted to the well-drained portions of the Atlantic and Gulf Coastal Plain areas, while the cowpea can be grown successfully not only there, but throughout the cotton belt and the lower half of the corn belt. The velvet bean and cowpea are quite sensitive to cold, whereas the soy bean withstands considerable frost in spring and fall. Cowpeas and velvet beans both succeed on poor soils better than the soy bean. For soil improvement the velvet bean is, in general, superior to either the cowpea or the soy bean, although the cowpea succeeds under a greater diversity of conditions.

The soy bean is to be preferred for forage purposes on account of its upright growth. The cowpea and velvet bean are viny plants and therefore more difficult to harvest and cure.

As a grazing crop for cattle and hogs in fall and winter the velvet bean can not be excelled. However, the cowpea and soy bean can be grown over a more extended area, and some of their numerous varieties furnish earlier pasture.

For the production of seed, the soy bean has many advantages over the cowpea and velvet bean. The soy bean matures all its seed at

one time and can easily be handled by machinery. Hand picking is most commonly practiced in gathering cowpea seed, although machinery can be used to advantage. It is necessary to pick velvet beans by hand because of the abundant, tangled mass of vines.

The seeds of velvet beans, cowpeas, and soy beans are all excellent feed for cattle and hogs. Cowpea seed, however, is rarely cheap enough for feed, but it is extensively used, especially in the Southern States, for human food. Soy-bean seed, in addition to its value for feed, is valuable for the production of oil and meal, and its use for human food is increasing.

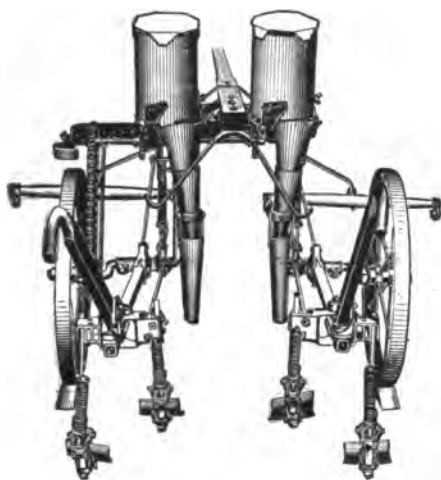
The cowpea will undoubtedly continue to be one of the most important leguminous crops in the Southern States. No other crop sown under such a diversity of conditions or receiving so little attention in soil preparation and cultivation succeeds so well. Under the most varied conditions forage, soil improvement, and human food are obtained.



GROWING CORN IN THE SOUTHEASTERN STATES

C. H. KYLE

Agronomist, Office of Cereal Investigations



Walking Cultivator Equipped with Fertilizer Distributors

FARMERS' BULLETIN 1149

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry

WM. A. TAYLOR, Chief

Washington, D. C.

September, 1920

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IN THE SOUTHEASTERN STATES larger yields of corn will be produced at less cost by giving greater attention to the following factors:

- (1) Drainage and humus.
- (2) Deep preparation of the land.
- (3) Judicious use of commercial fertilizers.
- (4) Special corn machinery.
- (5) Adjustment of the cultural method to meet the special requirements of the corn plant.

Corn plants require an abundant and uniform supply of moisture throughout the season. This requirement may be met by improving the water-holding capacity of the soil and preventing the growth of grass and weeds.

The supply of available plant food must be controlled so that there will be a moderate amount of stalk development and a proportionately large ear development. Planting as early as a stand may be secured in order that the early growth may be made in comparatively cool weather, planting in furrows, the application of commercial fertilizers as the particular case demands, and cultivation so that the most fertile portion of the soil is thrown from the rows early in the season and to the rows some time previous to the tasseling period, all tend to give this result.

Good tools specially designed for corn production will save much labor.

GROWING CORN IN THE SOUTHEASTERN STATES.¹

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SCOPE OF THIS BULLETIN.

IN THIS BULLETIN the culture of corn in North Carolina, South Carolina, Georgia, Florida, and Alabama is discussed. The recommendations and suggestions made apply mostly to the cotton-growing portions of those States.

PREPARING LAND FOR CORN.

CONSERVATION OF RAINFALL.

Although the average annual rainfall in the Southeastern States ranges from 46 to more than 60 inches and is comparatively well distributed, the most common need of the corn crop is more moisture at some time in its development. Preparation of the land so that it will retain larger quantities of water for longer periods is therefore very important and will give greater returns on the investment than any other one part of the crop's culture. The capacity of a soil for moisture depends largely on the depth to which the land is plowed and the quantity of humus (decaying vegetable matter) incorporated with it.

DRAINAGE.

Poor drainage is indicated in many fields by the irregular patches in which little or no corn grows. Even if actual drowning does not occur in these places, the growth is so weakened and retarded that worms commonly destroy the stand. Besides the usual means of draining, applications of coarse stable manure are recommended.

¹ This bulletin is a revision and extension of Farmers' Bulletin 729, entitled "Corn Culture in the Southeastern States," issued in 1916.



FIG. 1.—A reversible disk plow.

PLOWING.

Land should be broken from 8 to 10 inches deep. If it is in a poor state of cultivation this is best accomplished by turning only that part which previously has been broken and loosening the rest of the depth with a subsoil plow. This plow will be most efficient when it follows in the furrow of the turnplow. In succeeding seasons the land may be turned deeper, the increased depth varying with the quantity of vegetable matter incorporated during the last preparation. When a soil of the required depth has been established the turnplow may be run from 6 to 8 inches deep at each preparation and the subsoil plow only as often as seems necessary to prevent the formation of a compact layer just below the depth of the turnplow.

In order that the plows may accomplish the greatest amount of pulverizing, plowing should be done when samples of the soil crumble most readily in the hand. The period when the best work may be done frequently passes before all the land can be prepared. If the surface of the land is thoroughly pulverized with a disk harrow or other implement as soon as it is sufficiently dry, the period for efficient work will be greatly extended.

Figure 1 illustrates a disk plow that reverses, so that the furrows may all be turned in one direction. It is especially valuable on steep hillsides and where it is necessary to avoid open furrows.

Figure 2 illustrates a type of walking turnplow that is adapted to the mixed sand and clay soils of the South Atlantic States.

Harrows and other types of tools well adapted for pulverizing and smoothing the soil after it has been broken are now common in every community. Frequently, however, the land is not worked until its surface has dried. The closer the breaking plows are followed

by the surface tools, the less time and labor it will require to do the work.

HUMUS.

Nothing will do more to economize the labor of tilling the land and to prolong the good effects of tillage than the presence of an ample quantity of humus in the soil. All land intended for the profitable growing of corn should be stocked with such material as soon as possible. The best preparatory crops for corn are the legumes, some of which are cowpeas, velvet beans, vetch, the clovers, and beggarweeds. These crops may be made to supply much vegetable matter and, in addition, a part or all of the necessary nitrogen.

Manure produced in connection with the raising of live stock always has been associated with the highest type of agriculture. An inconsiderable quantity of it is at present produced on most farms, because there are so few animals. In the Southeastern States, where live stock run on pasture most of the year, manure does not accumulate as it does where the stock are fed in yards or stables for several months. Its great value, however, in connection with the production of corn and other crops should command careful consideration.

COMMERCIAL FERTILIZERS.

Commercial fertilizers should be used to supply such elements of plant food as can not be supplied by the soil and by cropping systems in sufficient quantities for the greatest profit. Usually it is desirable to supply nitrogen, phosphoric acid, and potash in some one or more of their various forms. The proportions of these fertilizer constituents that it is necessary to use vary with the soil and the general cropping system.

Extensive tests over a long period of years are urgently needed as a guide in choosing a fertilizer for each of the many different con-

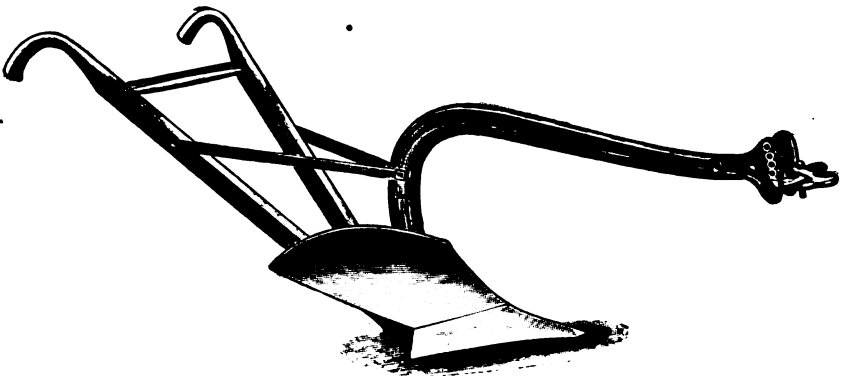


FIG. 2.—A good type of walking turnplow.

ditions in the section. Some of the most satisfactory data available are those of the North Carolina Agricultural Experiment Station. Formulas for fertilizers for corn and other crops based on conditions prevailing in the spring of 1920 have already been suggested in two articles by Prof. C. B. Williams,² agronomist of the North Carolina station. The recommendations printed in small type in the following paragraphs are taken from these articles. The formulas are as presented by Prof. Williams, but slight changes have been made in their presentation to suit the purposes of this bulletin.

Where the soil is well supplied with organic matter or where stable manure is applied in moderate quantities and where leguminous crops like cowpeas, soy beans, and clovers are plowed under, the amount of nitrogen required in the fertilizer or fertilizer mixtures will usually be considerably less than for the ordinary poor or moderately poor soils of the Southeastern States. In many cases, where the organic matter is high naturally or has been made so by the use of manures or by the plowing in of leguminous crops, nitrogen may be entirely left out or be reduced to a very small amount in the mixtures. For ordinary soils throughout the South the following or similar mixtures are to be recommended:

For the sandy and sandy loam soils of the Coastal Plain, which are low in organic matter, about 300 pounds per acre of a fertilizer containing 6 to 7 per cent of available phosphoric acid and 4 to 5 per cent of nitrogen should give good results. On very sandy soils, enough potash should be added to the mixtures to give about 2 per cent of this constituent.

For soils in the Piedmont and mountain districts that are low or moderately low in organic matter, use 200 to 400 pounds per acre of a mixture containing 10 to 12 per cent of available phosphoric acid and 3 to 5 per cent of nitrogen.

Where one is buying his own fertilizing materials and doing his own mixing, the following mixtures will give approximately the composition recommended. In these formulas sulphate of potash, carbonate of potash, and kainit have been suggested as the sources of potash. They may ordinarily be used interchangeably, utilizing the one which is cheapest in consideration of its content of potash.

In the selection of the best nitrogenous carrier or carriers for corn, one is to be guided by the relative cost per pound of nitrogen in the common carriers delivered at the farm and somewhat upon the nature of the soils on which the fertilizer mixtures are to be used. Generally speaking, the more open the soil the more important it becomes to use organic carriers in the fertilizer mixtures, at least in part, if applied at planting time.

The mineral sources of nitrogen, like nitrate of soda and sulphate of ammonia, are quite readily soluble in the soil water when applied. If these are used on leachy soils, such as coarse sands, as the sole source of nitrogen, in general they should be applied only to growing crops. In many instances it will be wise, too, to divide the application and make a side dressing just before the corn begins tasselling.

In the Piedmont and mountain sections there is usually very little likelihood of much loss of nitrogen of the more soluble forms when proper methods

² Williams, C. B. Fertilizers for Coastal Plain soils. *In Prog. Farmer*, v. 35, no. 6, p. 290, 320-322, illus. 1920.

— Fertilizers for Piedmont and mountain soils. *In Prog. Farmer*, v. 35, no. 7, p. 364-365, illus. 1920.

of soil conservation and tillage are practiced, even when the mineral resources are used at the time the crops are planted. Especially is this so with soils that contain a good clay subsoil.

Any of the nitrogenous materials in the following formulas, if found cheaper or for any other reasons more advantageous, may be substituted in the following equivalents:

100 pounds of 7 per cent cottonseed meal.
39 pounds of 18 per cent nitrate of soda.
70 pounds of 10 per cent fish scrap.
47 pounds of 15 per cent dried blood.
29 pounds of 24 per cent sulphate of ammonia.
70 pounds of 10 per cent tankage.

FERTILIZER MIXTURES FOR COASTAL PLAIN SOILS.

The formulas to be used should be governed by whether the farmer has any fertilizer materials on hand, and, if not, what will be the cheapest sources of nitrogen and potash, considering the precautions that will have to be observed in the use of materials carrying nitrogen, such as nitrate of soda and sulphate of ammonia. In calculating the formulas which follow, cottonseed meal has been included in a few, because this material is already in the hands of a large number of farmers, obtained in exchange for their cotton seed.

Where corn is grown on average sandy lands the use of the following fertilizer mixtures in the quantities indicated should give good paying results when properly put on and when the corn is properly planted and cultivated:

Formula No. 1:	Pounds.
Acid phosphate, 16 per cent.....	1, 170
Nitrate of soda, 18 per cent.....	830
Total	2, 000

This mixture is only suitable for use where the soils are of a retentive nature. Where they are very sandy with a sandy subsoil this mixture could not be used with satisfactory results.

When the soil is of a sandy or sandy loam nature with a clayey subsoil, the nitrate application can be divided, applying part of it at planting time with the acid phosphate and the other part as a side dressing at the rate of about 100 pounds per acre later. As the mixture given in formula No. 2 is a very concentrated one, only about 100 to 200 pounds of it ordinarily will be required for sandy and sandy loam soils. The formula for this mixture in ton lots is as follows:

Formula No. 2:	Pounds.
Acid phosphate, 16 per cent.....	1, 475
Nitrate of soda, 18 per cent.....	525
Total	2, 000

For very sandy soils with an open sandy subsoil where there is danger of soluble forms of nitrogen leaching out before the crop uses them, it is well to use a part of the nitrogen from organic sources, such as cottonseed meal, dried blood, fish scrap, or tankage, using the one that supplies nitrogen at the lowest rate per pound.

Below is calculated a formula where one-fourth of the nitrogen is derived from cottonseed meal. The other three-fourths of the nitrogen should be reserved as a side application to be applied previous to the time of tasselling at the rate of 150 to 160 pounds per acre. This mixture for ton lots is as follows:

Formula No. 3:	Pounds.
Acid phosphate, 16 per cent.....	1, 340
Cottonseed meal, 7 per cent.....	660
Total	2, 000

The foregoing mixture is a very concentrated one and may be used at the rate of 100 to 200 pounds for corn grown on Coastal Plain soils.

For very sandy soils in sections where fish scrap is available and is the cheapest or most advantageous source of nitrogen, it may be used in mixing in ton lots for corn as specified below:

Formula No. 4:		Pounds.
Acid phosphate, 16 per cent.....		435
Fish scrap, 10 per cent.....		1,225
Kainit, 12 per cent.....		340
Total.....		2,000

Where cottonseed meal is used on the average sandy soils, the following will be a very good proportion to mix in ton lots:

Formula No. 5:		Pounds.
Acid phosphate, 16 per cent.....		500
Cottonseed meal, 7 per cent.....		1,500
Total.....		2,000

FERTILIZER MIXTURES FOR PIEDMONT AND MOUNTAIN SOILS.

On the retentive soils of the Piedmont and mountain sections, nitrate of soda or sulphate of ammonia, if cheaper than other forms of nitrogen, may be used as the sole source of nitrogen for corn, provided proper precautions are observed in its use.

Following are some formulas with nitrate of soda as a sole source and one each with cottonseed meal and dried blood. If sulphate of ammonia is a cheaper source of nitrogen than nitrate of soda it may be substituted for it at the rate of 29 pounds of sulphate for 39 pounds of nitrate.

Formula No. 6:		Pounds.
Acid phosphate, 16 per cent.....		1,400
Nitrate of soda, 18 per cent.....		600
Total.....		2,000

Where the soil in the Piedmont and mountain sections is a little more open in its nature, the nitrogen application in many cases may be divided.

In formula No. 7 half the nitrogen as nitrate of soda is calculated for applying at planting time and the other half is reserved to be applied later as a side dressing at the rate of about 75 pounds per acre.

Formula No. 7:		Pounds.
Acid phosphate, 16 per cent.....		1,600
Nitrate of soda, 18 per cent.....		400
Total.....		2,000

Using cottonseed meal where it is the cheapest form of nitrogen available, it may be mixed in the following proportions:

Formula No. 8:		Pounds.
Acid phosphate, 16 per cent.....		1,000
Cottonseed meal, 7 per cent.....		700
Nitrate of soda, 18 per cent.....		300
Total.....		2,000

Using dried blood as the sole source of nitrogen, the following, in approximately the quantities indicated above, will be a good mixture to use when blood is as cheap as other forms or is the cheapest source of nitrogen:

Formula No. 9:		Pounds.
Acid phosphate, 16 per cent.....		1,200
Dried blood, 15 per cent.....		800
Total.....		2,000

No feature of the method of culture requires more intelligence on the part of the grower than the proper supply of commercial fertilizer to corn. For the man who is able and willing to meet the conditions in each case as they arise, the following suggestions are offered: Apply all the fertilizer that supplies nothing but phosphorus and potash on the line of the row at or before the time of planting. It should be mixed with the soil as thoroughly and widely as is practicable. If experience has shown that the early growth is liable to be so slow and weak that there is difficulty in getting a stand, from 25 to 30 pounds of nitrate of soda should be distributed with the seed. The remaining portion of the necessary nitrogen should be supplied from time to time while cultivating the corn. The amount of nitrogen supplied in this way should be governed somewhat by the rate at which the corn is growing. As a general rule, the early applications should be comparatively light and the late applications comparatively heavy, the idea being to avoid an excessively rapid and tender growth at any time and thus prevent some of the damage that is always likely to result from a drought.

Nitrate of soda is the best form in which to supply nitrogen by this system.

Fertilizer attachments for cultivators are the best devices for distributing nitrate of soda.

PLANTING.

TIME OF PLANTING.

The long seasons in the Southeastern States allow considerable latitude in the planting of corn. The question is frequently raised whether one should plant early (from the middle of March to the first week in April) or late (May 1 to July 1).

In considering the question, the budworm or southern corn rootworm is an influential factor.

Over the greater part of the area considered the worms appear most abundantly in April and the first week in May, though this period varies with the latitude and the weather. Many farmers try to plant either before or after this main attack, and it has been found that this practice is desirable.³

It has been observed that a cold, wet soil favors budworms. It is probable that artificial drainage will do much to prevent this trouble and thereby render the grower more independent as to the time of planting.

Much of the land in the Southeastern States has fairly good drainage and the soil early becomes warm and well aerated. On this land

³ Luginbill, Philip. The southern corn rootworm and farm practices to control it. U. S. Dept. of Agr., Farmers' Bull. 950, 12 p., 7 fig. 1918.

the budworms usually do little or no damage at any time, and the farmer is thus freed from the limitations just mentioned. On such land the heaviest yields of corn are usually obtained by planting as soon as a permanent stand can be secured.

MANNER OF PLANTING.

On warm well-drained soil it has become very common to plant corn in the water furrows left by plowing the land into beds, the width being that desired between the rows.

Planting in furrows has three special advantages:

- (1) The rate of growth of corn planted in furrows is most easily controlled.
- (2) The cultivation of furrow-planted corn at the time when root injury is usually most serious consists largely of working down the soil of the bed about the corn. Injury to the roots by the cultivators is therefore hardly possible.
- (3) Corn planted in furrows is much more easily kept clean in the row than that planted on the level, because in bedding many of the weed seeds are thrown out of the furrows, and as the corn grows the earth is filled in about the plants, and the weeds and grass that start there are easily covered.

The preparation of the furrows is usually made a special consideration after the land has been broken flat. The land is first bedded with a plow, a disk harrow, or a disk cultivator. The beds are made wide enough so that the furrows between them will be properly spaced for the rows. Another way that requires less labor and that protects the young corn from the wash of the beds is to open the furrows for planting with a middle breaker. The beds are then completed by throwing the soil away from the rows during the early cultivation. When the subsoil is naturally hard and the land is broken less than 8 inches deep, the bottom of these furrows is frequently loosened as deep as is practicable. The ordinary 1-horse planter is well adapted to planting in these furrows and on beds.

On land that has been properly prepared, much of the above-described labor may be eliminated, time saved, and the work better done by using a lister. These machines open the furrow and plant the corn below the level at the same time. They insure a uniform depth for the seed and make it possible to plant the seed shallow and yet in moist soil. Figures 3 and 4 show good types of the listers which are intended for compact land but will give satisfaction in freshly plowed land if it contains considerable sand. Figure 5 shows a field that has been planted with one of these machines. The rows shown in this illustration were $3\frac{1}{2}$ feet apart, but any other spacing may be used.

When the lister is used and it is desirable to apply commercial fertilizer before planting, a fertilizer drill should precede the planter on the line of the row and distribute the fertilizer slightly above

the depth at which the lister runs. By so doing, the lister will spread the fertilizer to at least the width of its cutting edge and to both sides of the seed, and the danger of injuring the sprouting corn by contact with the fertilizer will be removed.

On poorly drained clay land corn frequently will be drowned out if planted in furrows, especially if these are deep. Any clay land that has had shallow preparation will tend toward the same trouble. Under these conditions the furrows must be shallow or the planting made on the level of the land.

In some cases on low coast land corn must be planted in beds, so that after rains the water will be permitted to escape before the crop is damaged. It is then advisable to make the beds wide enough for two or more rows.

In planting, the seed should be covered just deep enough to have sufficient moisture in which to germinate promptly. A depth greater than this tends to weaken the plants and thus lessens their chances for success. On well-prepared clay land, and especially where the planting is in a furrow, a half inch of cover may be sufficient. When the soil is dry, cloddy, or otherwise poorly conditioned for planting it is necessary to plant deeper.

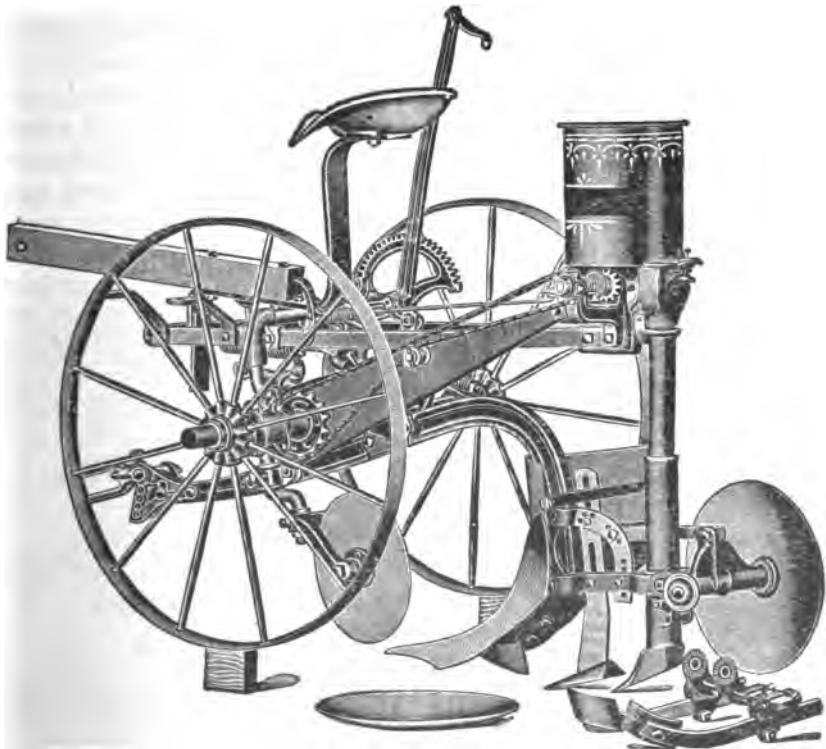


FIG. 3.—A riding lister.

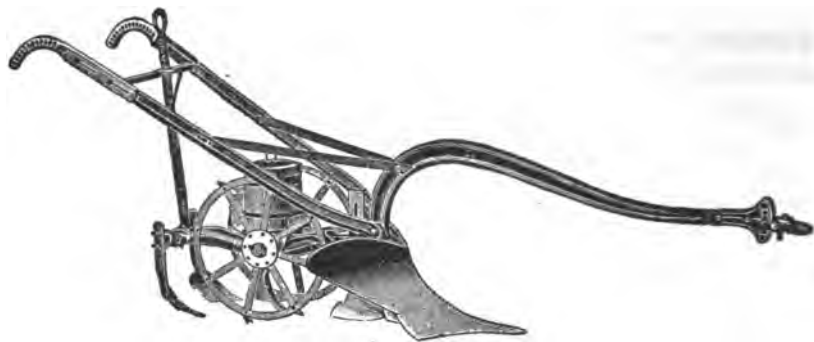


FIG. 4.—A walking lister.

DISTRIBUTION OF PLANTS.

The best distribution of plants over the land is obtained by making the distances between single plants in the row and the distances between rows the same. With such an equal distribution, the least possible loss from competition is experienced. However, in order that sufficient plants be grown upon an acre to utilize most completely the resources of the soil and climate and at the same time permit tillage and other desirable practices, it is usually necessary to sacrifice some of the advantages of even distribution for those to be gained by other desirable cultural practices. These practices frequently may be altered so as to reduce this loss, and the greatest saving in this connection is by means of implements specially adapted to this work. Where general-purpose implements are used, distances between rows of as much as 5 or 6 feet are often considered necessary. By preparing the land thoroughly and then using special machinery for planting and cultivating the corn, the rows need be no more than $3\frac{1}{2}$ feet apart and the distances between plants in the rows can be increased accordingly.

NUMBER OF PLANTS PER ACRE.

The number of plants per acre required for the best results will depend more or less upon the natural fertility of the land, the quantity of fertilizer used, the method of culture practiced, the time of planting, the evenness of the distribution of plants, whether other crops are grown with the corn, the variety, and the season.

The season is, of course, the most important factor influencing the stand required, and as its character can not be foretold, it is evident that specific advice in this connection can not be given.

In practice, corn in the Southeastern States is commonly planted in stands ranging from 3,630 to 7,260 plants per acre, or 12 to 6 square feet per plant. Most stands of corn have been planted with an allowance of 8 to 12 square feet per plant.

Probably the most important factor involved in the proper adjustment of the stand to the ever-varying environment lies within the variety itself. Plants of all varieties of corn tend to adjust themselves to their growing conditions by increasing or decreasing the stalk yields. As a general rule, the varieties capable of the widest range of adjustment are those that have a strong tendency to produce more than one ear per stalk.

GETTING A STAND.

One of the greatest losses due to a defective stand is from the blank spaces seen to a greater or less extent in practically every field. The ability of the plants to utilize extra space rapidly diminishes as the distance increases, and the practical limit probably does not exceed 5 or 6 feet. Beyond this distance the loss, so far as the corn crop is concerned, is complete.

Good seed of a uniform size and shape is an important factor in securing a stand. Special bulletins upon seed corn can be obtained without cost from the United States Department of Agriculture.

Crows frequently do severe damage to the stand by eating the seed or by pulling up the very young plants. Odorous substances have been tried in various ways to prevent such attacks. The substance that is most favorably considered for this purpose at present is coal tar. The seed should be wet with warm water before adding the tar. A teaspoonful of the tar will be sufficient for a peck of corn. The mass must be thoroughly mixed and then dried before planting.

Blank spaces are commonly due to clods and trash that prevent the planter from properly packing the seed in fine moist earth. This trouble can be practically eliminated by using a lister.



FIG. 5.—A field after planting with a lister.

In wet, cold land the seed sometimes is covered with too much soil. On such land the seed should be planted just deep enough to have it in contact with moist soil.

Large quantities of acid fertilizer applied in the row at or about the time the corn is planted may kill sprouting seed or cause the plants to be weak. The trouble may be overcome by making the application ten days or two weeks earlier.

Whenever it is at all difficult to get the desired stand, extra seed should be planted to offset the loss. Thinning will usually result in greater economy than leaving a defective stand or replanting.

CULTIVATION.

Cultivation may be for one or more reasons. Some of these are as follows:

(1) By cultivating the soil away from the row while the corn is young it may retard the rate of growth and thus under certain conditions will favor the success of the crop.

(2) By cultivating the beds between rows of furrow-planted corn to a level, the corn may be suddenly put within immediate reach of the soil's greatest fertility. If this is done at the right time, it will favor the greatest production of grain.

(3) Weed destruction is one of the most important functions of cultivation. Weeds are most easily destroyed as they are coming through the surface of the ground. Thorough surface cultivation will suffice at this time. When weeds and grass are well started, not only is there a rapid exhaustion of the moisture and plant food in the soil but the cultivation necessary to remove them will often seriously damage the crop by covering the corn and, when planted on or above the level, breaking its roots.

(4) When it is desirable to supply commercial fertilizer to the growing crop it is sometimes necessary to mix the application with the soil. For this, cultivation may be required, and the most practical way is to combine this with one of the usual cultivations.

(5) Shallow early cultivation by maintaining a loose soil mulch will conserve soil moisture. Deep early cultivation by permitting more air to enter will dry and warm the soil about the corn. After corn is from 2 to 3 feet high (varying with the space between rows), its roots so fill the soil that it is believed that practically no moisture on its way to the surface can escape them. For this reason late cultivation for the sole object of conserving moisture is now considered impracticable.

When corn is planted in furrows, the early cultivation need consist of little more than harrowing the bottom of the furrows on both sides of the row. If the furrows were made with a lister, a harrow of the type shown in figure 6 is the best. The uniform furrows guide the different sections of the harrow. The mules or horses walk upon the beds and soon require but little attention. One man is thus able to cultivate as many as five rows at a time. If the furrows were made by other means, as previously described, the early cultivation

may be done with cultivators of the type shown in figure 7. In this case, the clevis will have to be so adjusted that the horse or mule can

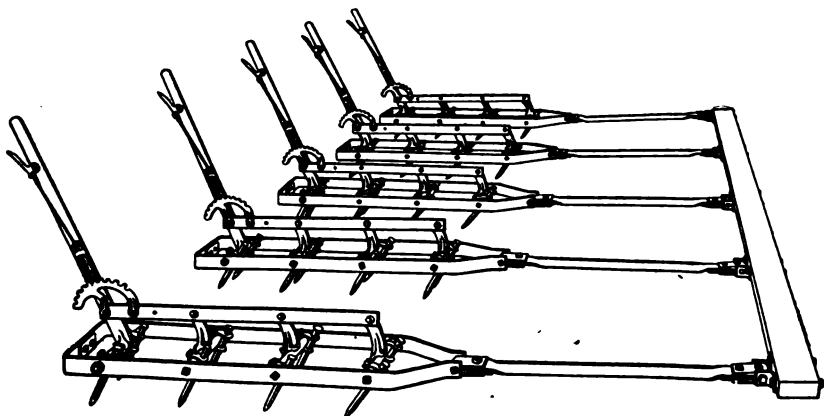


FIG. 6.—A harrow for cultivating corn in lister furrows.

walk just to one side of the row, while the cultivator works both sides of it. It is also necessary to remove at least one of the teeth on each side. The early cultivations of furrow-planted corn should leave the furrows entirely open. If it is desirable to leave them open very late, the beds may require cultivation in order to pre-

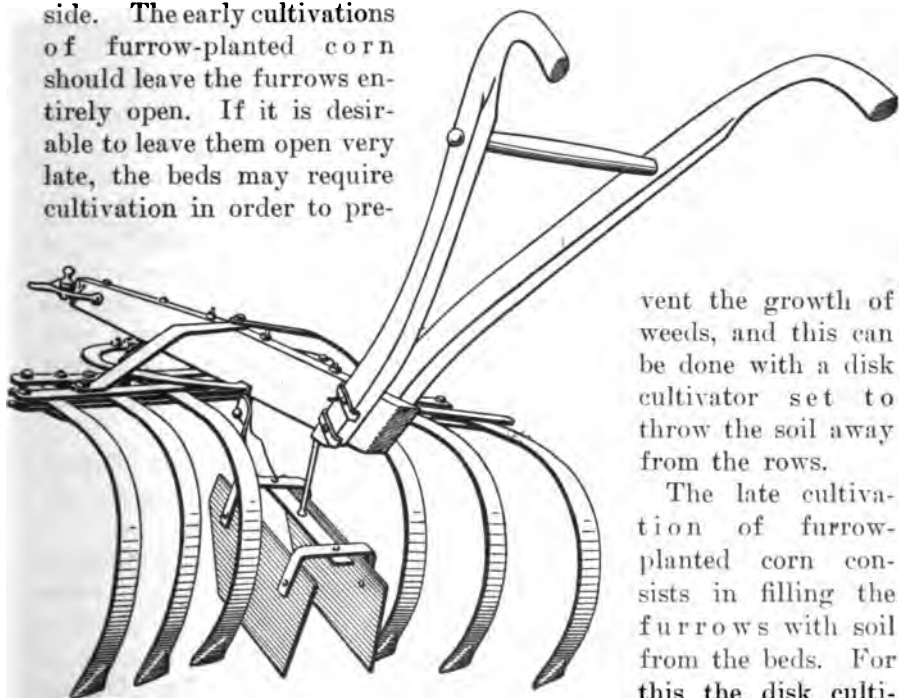
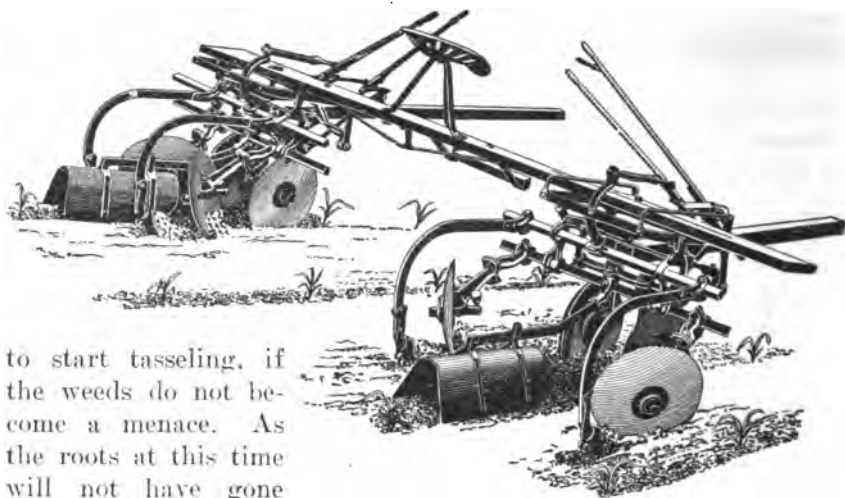


FIG. 7.—A cultivator that can be used to cultivate corn in an ordinary water furrow.

vent the growth of weeds, and this can be done with a disk cultivator set to throw the soil away from the rows.

The late cultivation of furrow-planted corn consists in filling the furrows with soil from the beds. For this the disk cultivators are among the best. This level-

ing process may be done in one or more cultivations, as seems desirable. It may be delayed until it is apparent that the corn is about



to start tasseling, if the weeds do not become a menace. As the roots at this time will not have gone upward into the beds that have been formed

FIG. 8.—A cultivator specially constructed for the first two or three cultivations of lister-planted corn.

between the rows, a loose, deep, rich mulch may thus be thrown about the stalks without the slightest damage, leaving the crop well prepared to pass its most critical period.

In order to destroy weeds, other cultivations may follow the leveling of the land. This should be done, however, with surface-working cultivators, so that it will not be possible to cultivate deep.

A smoothing harrow with teeth pointing backward, or, where the soil is very mellow, a horse weeder with long spring teeth, may be used for the cultivation of corn planted on or above the level of the land until the corn is 6 inches high. After this any cultivator that will not exceed a depth of 2 inches may be used. When the corn is drilled the weeds in the row will have to be removed with a hand hoe. In some cases the corn may be planted in hills, so that it can be cultivated both ways. Much hoeing may thus be eliminated.

Figure 8 illustrates a type of cultivator that is especially adapted to the cultivation of corn in furrows made by a lister. This one cultivates two rows at a time, but 1-row cultivators of this type are made. These machines are so constructed that they are guided by the furrow, and when properly adjusted anyone who is able to drive a team can cultivate two rows at a time in the best manner possible. In using these cultivators the rows are usually gone over once or twice with the disks set to throw the soil from the corn. During the third cultivation the disks are set to throw the soil to the corn, and at this time the furrows are nearly filled. The fourth and last cultivation is usually done with a high-arched cultivator of one of the types shown in figures 9 and 10. In each of these illustrations

the cultivators are equipped with scrapers that smooth the land behind the disks or knives. For the fourth cultivation the gangs on the disk cultivator should be set to throw toward the row, or in the opposite direction from that shown. This cultivation may also be done with harrows or any other tool that will cultivate shallow (from 1 to 2 inches deep) and leave the land free from ridges and furrows.

Figure 11 shows a cultivator equipped with fertilizer attachments, so that a side application may be made at the time the corn is cultivated. Fertilizer-distributing attachments can be made for most kinds of corn cultivators, and manufacturers will produce them when there is a sufficient demand. In a large portion of the section covered by this bulletin such attachments, conveniently and substantially made for the types of cultivators illustrated in figures 8, 9, and 10, should not only economize the time and labor necessary for distributing the fertilizer, but by being able to supply the fertilizer at each of the cultivations a farmer will not need to apply a large quantity at any one time, and the danger of overstimulating growth will be practically eliminated.

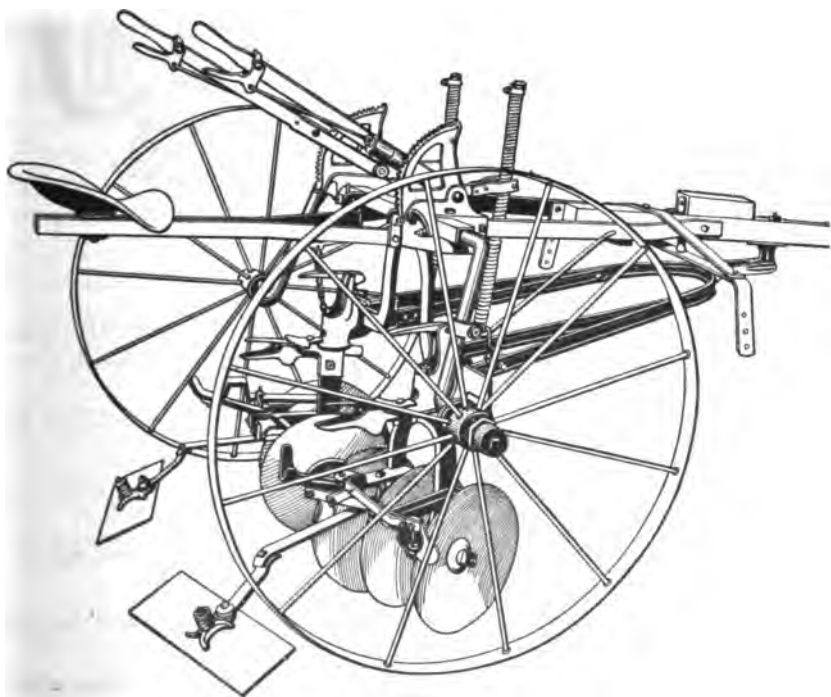


FIG. 9.—A disk cultivator equipped and adjusted so the land will be left level.

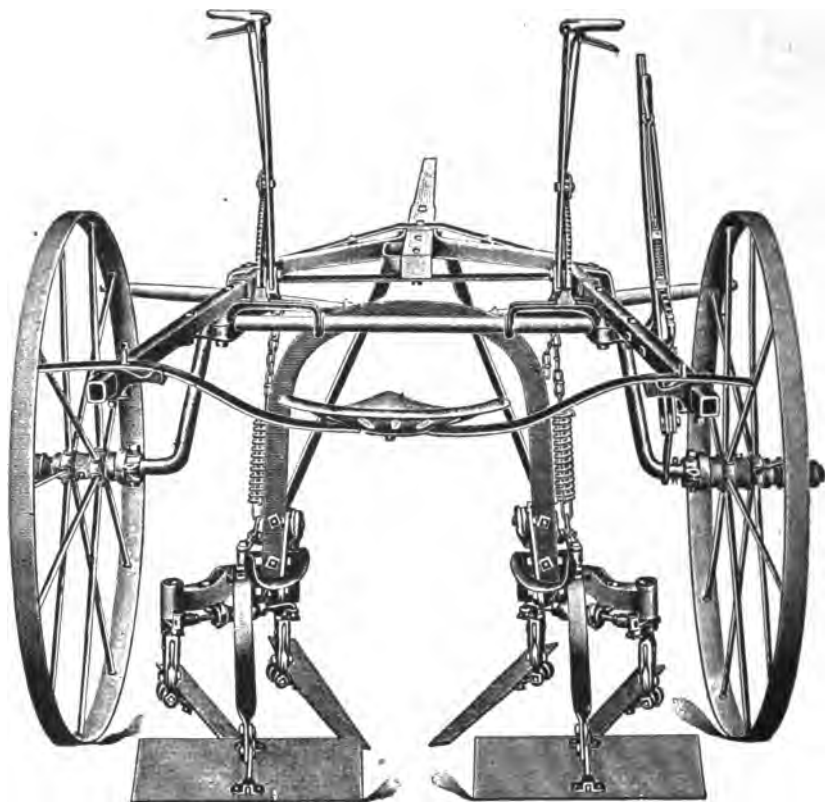


FIG. 10.—A cultivator specially adapted for level shallow cultivation.

SUMMARY.

The recommendations and suggestions made in this bulletin apply mostly to the cotton-growing sections of North Carolina, South Carolina, Georgia, Florida, and Alabama.

Drainage and coarse stable manure should be used to prevent the irregular patches in the field in which little or no corn grows.

More of the rainfall is retained when the land is broken from 8 to 10 inches deep and vegetable matter is supplied.

Humus economizes the labor of tilling the land and prolongs the good effects of cultivation.

Crops like cowpeas, velvet beans, vetch, the clovers, and beggar-weeds may be made to supply both humus and nitrogen.

Commercial fertilizers should be used to supply such elements of plant food as can not be supplied by the soil and by cropping systems in sufficient quantity for the greatest profit.

The fertilizer formulas published by the North Carolina and South Carolina agricultural experiment stations are recommended.

Budworms may make it necessary to plant after the first of May, but drainage may relieve this condition.

The heaviest yields of corn are usually obtained by planting as soon as a permanent stand can be secured.

On warm well-drained land corn in furrows has the advantage over that planted by other methods, because its growth may be better controlled, serious injury to the roots in cultivating is avoided, and weeds and grass are more easily combated. Special attention is called to the desirability of using a lister.

The seed should be covered just deep enough to have sufficient moisture in which to germinate promptly.

A more uniform distribution of plants, resulting from a decrease in the distance between rows and an increase in the distance between plants in the rows, is often desirable, and this may be accomplished by the use of special machinery.

Most stands of corn are planted so as to allow from 8 to 12 square feet per plant. Plants of all corn varieties tend to adjust themselves to their growing conditions by increasing or decreasing the stalk yields, but as a general rule the varieties capable of the widest range of adjustment are those that have a strong tendency to produce more than one ear per stalk.

Crows may be deterred from eating the seed and pulling up the young plants by using coal tar.

Where the present methods fail to give a stand in cloddy or trashy land, a lister will usually succeed.

Where it is at all difficult to get the desired stand, extra seed should be planted. Thinning will usually result in greater economy than leaving a defective stand or replanting.

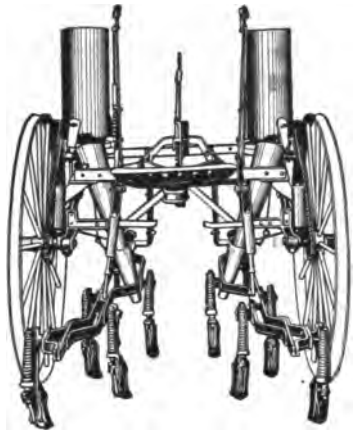


FIG. 11.—Riding cultivator equipped with fertilizer distributors.

FARMERS' BULLETIN 1150
UNITED STATES DEPARTMENT OF AGRICULTURE

PARASITES AND PARASITIC DISEASES OF SHEEP



SHEEP PROBABLY SUFFER more from parasites than do any other kind of livestock.

Most of our loss in sheep, mutton, and wool is from animal parasites, as sheep suffer comparatively little from bacterial diseases.

Lambs and young animals are most susceptible to parasites and suffer most from them.

It is the sheepman's business to *prevent* disease. When disease is present it is advisable to call in a competent veterinarian.

Pasture rotation, use of forage crops, feeding from racks or bare floors, draining or filling swamps, and restraint of wandering dogs are measures of value in parasite control. *Permanent pastures perpetuate parasites!*

Parasite eggs pass in the manure, usually. The disposal of the manure determines the fate of these eggs.

Parasitized animals usually do not have fever; they are unthrifty. This unthriftiness may have a fatal termination.

Act promptly to ascertain the trouble when sheep become unthrifty. A post-mortem examination of one of the sick animals may disclose the trouble and save the others.

Contribution from the Bureau of Animal Industry

JOHN R. MOHLER, Chief

Washington, D. C.

December, 1920

PARASITES AND PARASITIC DISEASES OF SHEEP.

MAURICE C. HALL, *Zoological Division.*

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LIABILITY OF SHEEP TO PARASITIC DISEASES.

SHEEP are very liable to attack by parasites, probably suffering more severely from this cause than any other kind of livestock. The importance of parasites and parasitic diseases of sheep is the more evident because of the fact that sheep are but little subject to serious bacterial plagues or virus diseases. They are practically immune from tuberculosis, which is one of the serious conditions in cattle and swine, and among sheep there is nothing comparable to the devastating outbreaks of hog cholera among swine. Occasionally a virulent strain of the bacillus producing lip-and-leg ulcer will spread under favorable conditions and necessitate the treatment of entire flocks, or individual sheep will die of pneumonia or other bacterial diseases, but the steady loss of sheep, mutton, and wool from disease in this country is due mostly to parasites.

The damage from parasites is greatest as a rule among lambs and young animals. The young tissues seem less resistant and more intolerant of injury and the more sensitive nervous system breaks down more quickly under the influence of parasitic injury and poisoning from the excretions and secretions of parasites. It also seems to be fairly well established that in general young animals

are more easily infected by parasites than older ones, although very old sheep sometimes appear to acquire an increased susceptibility to infection. Hence it is important in undertaking to prevent infestation with parasites to pay especial attention to the care and handling of lambs and yearlings.

IMPORTANT PREVENTIVE MEASURES.

The use of measures intended to prevent sheep from becoming infested with parasites is especially the function of the sheepman. When sheep become diseased, the niceties of diagnosis and the administration of drugs are well within the province of the veterinarian. Errors in diagnosis by unskilled persons waste valuable time and lead to useless or injurious measures. Drugs intended to kill parasites are from the nature of things usually very potent, and are commonly poisonous substances capable of doing much damage in the hands of unskilled or careless persons; therefore, it is usually advisable to secure the services of a competent veterinarian whenever there is an outbreak of disease and a good veterinarian is available. In places where there are no qualified veterinarians available, the farmer or stockman must use his own judgment in determining whether he can recognize the trouble and administer the remedy.

One of the most important preventive measures in keeping flocks free from parasites is based on the fact that many of the sheep parasites live in the digestive tract of the sheep or in organs in communication with the digestive tract, so that the eggs or young worms pass out in the manure and thus infect the pastures. The fact that sheep manure carries worm infestation is the basis of such preventive measures as pasture rotation, rotation of different kinds of stock on the same pasture, feeding from racks or board floors, use of bare lots for nursing lambs, etc.

Another important preventive measure is based on the fact that many parasites which do not get back to the sheep from a pasture infected with sheep manure are carried back to the sheep by dogs. The fact that the dog which feeds on uncooked sheep meat or viscera may become infested with worms that produce eggs which pass out on to the pastures and may then infect the sheep, is the reason for keeping sheep dogs and other dogs on the farm free from worms and related parasites and for insisting that stray dogs must not wander over pastures and fields under penalty of being shot. Another preventive measure is based on the fact that diseases like scab are transmitted by contact with infected animals and places, and clean flocks must be protected from unsafe contacts.

In a general way, the presence of parasites may be suspected as the cause of disease where there is little or no fever, the animals losing

condition and becoming thin and commonly having a diarrhea or being constipated. Other features may be associated with certain parasites. Bloodsucking parasites produce anemia, the blood becoming thin and pale as a result of having too few red blood corpuscles for the amount of serum present. Often there is associated with this an edema, in which fluid accumulates in the pendant or lower portions of the body; this is especially prominent in stomach-worm infestation in sheep, the fluid accumulating under the lower jaw and giving rise to the so-called "bottle jaw."

In this connection, the advisability of finding out promptly the cause of the trouble when sheep become diseased should be emphasized. Curtice has stated the case as follows:

The sheep owner who discovers weakness among his lambs should not wait until one of them dies before he endeavors to make a diagnosis, but should undertake to diagnose the disease in the earlier stages by sacrificing one or more of the worst affected, and thus gain time in treating and preventing the extension of the disease. By waiting for the disease to develop he allows the lambs to grow poorer and weaker, and when action is finally undertaken it is upon patients which are, in many cases, already too weak to stand vigorous treatment and which in no way profit by preventive measures as they should.

EXTERNAL PARASITES.

External parasites are those which live on the exterior of another animal called the host animal, that is, on the skin or in the layers of the skin or in the hair follicles. Internal parasites are those which live in the body tissues or cavities of the animal that serves as a host.

The external parasites of sheep are all arthropods, or animals having 6 or more legs, some of them being insects, which have 6 legs in the adult stage, others, such as mites and ticks, being more closely related to the spiders and possessing 8 legs in the adult stage. Some of these parasites spend their lives on the sheep; this is true of the scab mites and the lice. These are the important forms. Others, such as various kinds of biting flies, attack sheep occasionally but spend much of their lives off the sheep.

LICE.¹

Location.—Lice live on the skin of sheep, crawling about on the wool or hair from place to place and clinging to the wool fibers or hairs in feeding. The sucking body louse (*Hæmatopinus ovillus*) is commonly found in colonies on various parts of the body, including the face. The foot louse (*Linognathus pedalis*) is usually found on the lower portions of the legs, below the true wool and in the short, coarse hair. The biting louse (*Trichodectes ovis*) occurs on various parts of the body.

¹ *Hæmatopinus ovillus*, *Linognathus pedalis*, *Trichodectes ovis* (= *Tr. sphaerocephalus*).

Appearance.—The sucking body louse has a head somewhat longer than the thorax (fig. 1). The abdominal segments bear two rows of long hairs. The male is 2.1 millimeters (about one-twelfth of an inch) long and the female is 2.8 mm. (about one-tenth of an inch) long. There is an inconspicuous eye on each side of the head. The wool in the region attacked by this louse is usually discolored and contains numerous brown particles, the fecal deposits of the lice.

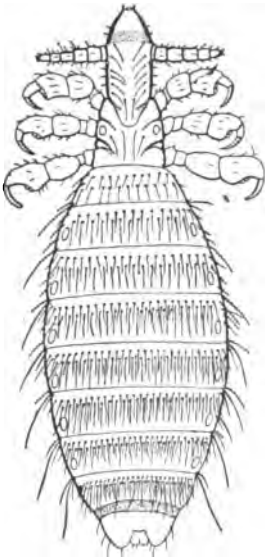


FIG. 1.—Sucking body louse (*Haematopinus ovillus*). Female, back view. Highly magnified. (From Neumann, 1907.)

The foot louse has a short head, as wide as it is long, which merges into the thorax, with reddish oblique bands on each side (fig. 2). No eyes are present. The abdominal segments bear two rows of hairs, of which those at the lateral margin are longer than the others. The female is 2.2 mm. (about one-twelfth of an inch) long and 1 mm. (one-twenty-fifth of an inch) wide; the male is broader and flatter. This is a sucking louse like the preceding species.

The biting louse has a head that is wider than long, with a broad, round anterior end (fig. 3). The abdominal segments show a median dark line and have only a single row of hairs. The male is 1.4 mm. (about one-twentieth of an inch) long and the female is 1.6 mm. long.

Life history.—The eggs of the various species of sheep lice are attached to the hair or wool in the sites customarily infested by the adult lice. The eggs of the sucking lice are said to hatch in 10 to 18 days; those of the biting lice in 5 to 8 days ordinarily, or 10 days in cold weather. Available evidence indicates that the young lice become mature and begin laying eggs in the course of about two weeks after hatching. The sucking lice, as the name implies, are bloodsuckers. The biting lice feed on the epithelial scales and other material on the surface of the skin. Lice usually cause little trouble in summer, but become more numerous and annoying in winter.

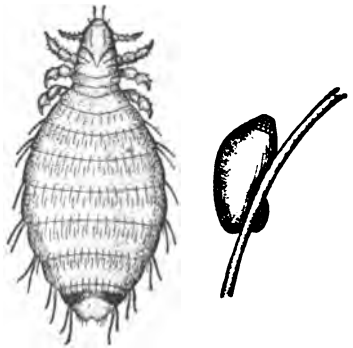


FIG. 2.—Sheep foot louse (*Linognathus pedalis*). Adult female and egg, enlarged. (From Osborn, 1896.)

Distribution.—Biting lice are rather common in the United States. The sucking body louse is fairly common on sheep in the Southwest. The foot louse has been found on sheep in various parts of the country.

Symptoms and lesions.—Lice, whether biting lice or sucking lice, cause itching and irritation. This of itself interferes with nutrition, and affected animals fail to fatten or keep in condition as they should. Moreover, the itching leads to scratching, with a resultant loss of wool, and this scratching adds more time lost from feeding to that lost from discomfort. Scratching may also cause cuts and bruises. The loss of nervous energy and the interference with feeding and nutrition tend to stunt the growth of young animals, interfere with the fattening of the entire flock, and predispose to other diseases by lowering the vitality. Actual lesions in the form of sores are caused where numerous biting lice cluster. The sucking lice abstract blood and lymph in considerable quantities where the lice are numerous. Finally, the excreta of the lice soil the wool, sometimes to a considerable extent; this is particularly true of the sucking body louse.

Lice are readily found on infested animals by examining them carefully, preferably in direct sunlight.

Treatment.—Where sheep are infested with biting lice only, sodium fluorid may be applied in the form of a powder to get rid of them, a single application sufficing for this purpose. The powder is rubbed into the skin at a number of places so as to insure a good distribution. It is of no value against sucking lice.

For sucking lice it is necessary to use a contact poison, and these poisons are also satisfactory for biting lice. In cold weather, where dipping is inadvisable, insect powders, composed largely of pyrethrum and naphthalene, may be used as a control measure and will serve to control the lice, but are not satisfactory in eradicating them.

For dipping, the substances which have been found effective in field tests are coal-tar creosote, cresol, arsenical dip, and 0.07 per cent nicotin solution with 2 per cent flowers of sulphur. To eradicate lice it is usually necessary to dip at least twice, with an interval of 14 to 16 days between dippings, in order to kill the lice that hatch out after dipping, since these dips can not be depended upon to kill all the eggs or "nits." Spraying is generally unsatisfactory as a method of applying dips to sheep, as it is too difficult to wet the wool.



FIG. 3.—Sheep louse (*Trichodectes ovis*). Adult female, enlarged. (After Neumann, 1892.)

Sheep should be handled carefully, not roughly. Dip the bucks, ewes, and lambs separately. The sheep should be fed and watered from 3 to 6 hours before dipping, in order that they may not be hungry or thirsty and yet not gorged with food. In hot weather they should be cooled off before dipping, and when the nights are cold they should be dipped in time to dry off before night. Ten days should elapse after shearing before dipping, in order that cuts may heal, especially when arsenical dips are used. Because of their extremely poisonous nature it is usually inadvisable to use arsenical dips in treating sheep.

Prevention.—To prevent infestation with lice it is essential that contact with lousy animals be prevented and that animals free from lice be kept out of sheds, pens, inclosures, or pastures where lousy stock has been present within three weeks. After the first dipping, sheep should be put on clean pastures or held in clean inclosures to allow time for any eggs to hatch and the lice to die, or else the sheds and lots should be thoroughly cleaned out and disinfected before using them. For this sort of disinfection the coal-tar dips in double the strength used for dipping are satisfactory.

THE SHEEP TICK.*

Location.—The sheep tick occurs in the wool and on the skin.

Appearance.—The sheep tick is not really a tick, but is a kind of wingless fly (fig. 4). It has 6 legs, whereas the full-grown true ticks have 8 legs. The mouth parts are very similar to those of other flies. These insects are reddish or gray-brown in color, and are about a quarter of an inch long on an average, and may therefore be easily distinguished from the lice. They are distinctly divided into head, thorax, and abdomen, which distinguishes them from the true ticks, which are occasionally found on sheep, as these true ticks have the thorax and abdomen fused, with the head not conspicuously distinct.

Life history.—The egg of the sheep tick is not laid as such, but is retained in the body of the female until it develops into a larva or pupa, which occurs in about seven days. The pupa is then deposited by the tick and is attached to the wool of the sheep by a gluelike substance. When deposited it is covered with a soft, white membrane, which becomes brown and hard in about 12 hours. The pupæ of the sheep tick are commonly called eggs. The young ticks emerge from the pupal stage in 19 to 24 days, the shorter time being in warm weather and the longer in cold weather. The tick is almost full-grown when it leaves the pupal case and it becomes mature in 3 to 4 days. After copulation the female may deposit its first pupa in 8 to 10 days.

* *Melophagus ovinus*. For additional information see Farmers' Bulletin 798 on "The Sheep Tick."

Distribution.—Sheep ticks are widely distributed over the world and are common in the United States on both farms and ranges. Where dipping of range sheep for scab has been practiced it has kept down the sheep tick, but where it has ceased sheep ticks have become very prevalent. They are most common on coarse-wool and medium-wool sheep, and prefer the neck, breast, shoulders, belly, and thighs.

Symptoms and lesions.—The damage done by the sheep tick is of two kinds. It is a bloodsucker, thus causing great irritation, loss of blood, interference with feeding, and consequently poor nutrition and reduced vitality. It lives in the wool and lowers the value of the wool by soiling it with the excreta and with the pupal cases. The loss caused is in addition to the wool deterioration which results from the injury to the sheep itself. The ticks may be easily found on parting the wool. Their presence may be suspected when sheep bite, scratch, or rub, and show a ragged fleece as a result.

Treatment.—The treatment for ticks is dipping. The coal-tar creosote, cresol, nicotine, and the lime-sulphur-arsenic dips are all satisfactory, but dips containing arsenic are not desirable for sheep. Dip twice at a 24- to 28-day interval.

Prevention.—All places which have been occupied by ticky sheep should be regarded as dangerous from this standpoint for a period of two months, as the pupæ may retain their vitality under certain conditions for almost this length of time. Usually pupæ remain in the wool, but wool containing pupæ may be rubbed off or pulled off and young ticks hatching from such pupæ may afterwards get on sheep. If inclosures are to be used for clean sheep within this period they should be thoroughly cleaned and the litter and manure disposed of in such a way that sheep can not come into contact with them until after the lapse of the 60-day period. A strong solution

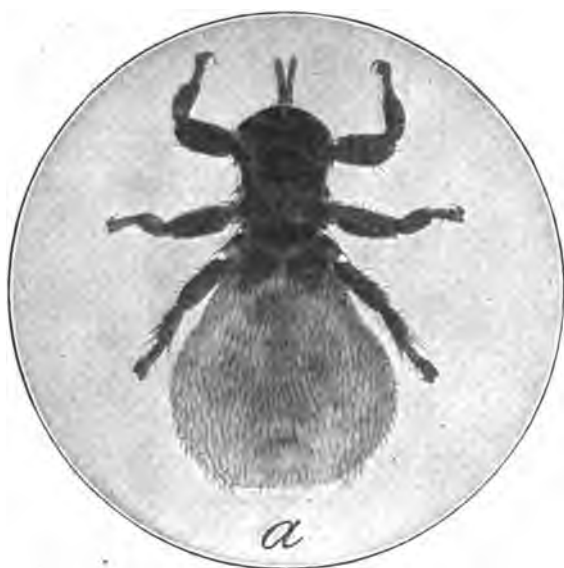


FIG. 4.—Sheep tick (*Melophagus ovinus*). Engorged female, enlarged. (From Imes, 1917.)

of coal-tar dip should also be used, but this can not be depended on to kill the pupæ, though it is useful in killing the ticks that might escape a cleaning process. To disinfect stone or wire-fence corrals, brush or straw may be scattered over the surface of the ground and burned. Clean sheep must be kept away from contact with ticky sheep and care must be taken to see that goats or other animals do not convey ticks to the sheep. Even persons may occasionally carry

ticks for a short time in their clothing, and this must be kept in mind at shearing time and whenever there is danger of infection from persons who travel from one flock of sheep to another.

SHEEP-SCAB MITE.*

Location.—On the skin.

Appearance.—These parasites are very small animals, commonly called scab mites (fig. 5). The male is only 0.5 mm. (one-fiftieth of an inch) long and the female 0.625 mm. (one-fortieth of an inch), but they may be seen with the naked eye as small white objects, especially when placed on a dark back-

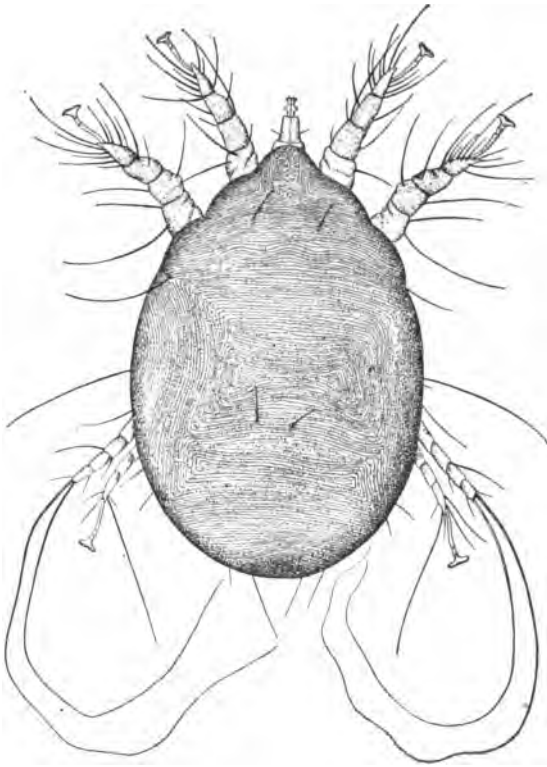


FIG. 5.—Sheep-scab mite (*Psoroptes communis ovis*). Female. Back view, greatly enlarged. (After Salmon and Stiles, 1898.)

ground. It is easier to see them when they are warmed, by sunlight or otherwise, on such a background, as they may then be seen in motion. The full-grown mites have 4 pairs of legs and these legs have long hairs. In the female there is a so-called sucker on a jointed stalk on the tip of the first, second, and fourth pairs of legs, and in the male on the first, second, and third, the fourth pair in the male having a sucker which is not on a jointed stalk.

* *Psoroptes communis ovis*. For additional information see Farmers' Bulletin 713 on "Sheep Scab."

Life history.—The female mite usually deposits at least 15 eggs during her life, and may deposit 24. In 3 or 4 days these hatch, the young mites beginning life with only 6 legs. In 7 or 8 days these have become 8-legged mites, which mate and begin depositing eggs in the course of the next 3 or 4 days. One investigator (Gerlach) has estimated that in 90 days this rate of reproduction under favorable circumstances, beginning with a single impregnated female, would produce one and one-half million mites.

Distribution.—Scab was formerly widely distributed over the United States, being the greatest pest that sheepmen had to contend with. Quarantine and eradication dippings have nearly cleaned it out of the greater part of this country, so that at present



FIG. 6.—Characteristic scab lesion in early stages of the disease. (From Imes, 1916.)

it is largely a matter of cleaning up the relatively small amount that is scattered about, an exceedingly difficult task, however, because of the scattered condition of the infection. The cooperation of individual owners in promptly reporting to local livestock sanitary authorities cases of scab or cases suggestive of scab is highly important in scab eradication.

Symptoms and lesions.—The scab mite pricks the skin and sucks the blood serum. The puncture becomes inflamed, forming a small red spot with a slight exudation of serum. This serum forms the scab, from which the disease takes its name (fig. 6). The watery part of the serum dries out, leaving a small crust for each bite, the total aggregate of these bites leading to the formation of considerable crusts or scabs. At the same time the bite of the mite causes itching, and this in turn leads to scratching, rubbing, and biting,

thereby adding to the initial inflammation and producing a certain amount of hemorrhage as the scabs are rubbed off and sores form. The serum and sores afford lodging and favorable conditions for bacteria and become infected. The skin reacts to the continued inflammation and becomes thickened.

The first symptom noticed as a rule is the itching, manifested by a disposition to rub and scratch. The wool is roughened and broken by the scratching, and this condition suggests the possibility of scab. The sheep become restless and spend considerable time biting and rubbing the affected spots, finally losing the wool off large



FIG. 7.—Scabby buck with entire hind quarters and flank affected. (From Imes, 1916.)
(The discolored area is due to dip stain from hand dressing.)

areas and leaving scabby sores (fig. 7). The time and energy spent in trying to alleviate itching is time and energy lost from feeding and growing, and this fact shows itself in the poor condition of scabby sheep. Ultimately many of these sheep will die unless treated and they are always so weakened as readily to fall victims to other diseases.

The diagnosis of this disease is best made by a capable veterinarian, as the disease is too serious to warrant taking any chance on its spread. Itching, loss of wool, and other conditions present in scab may also be shown in the presence of lice, sheep ticks, true ticks, bearded seeds, cactus spines, eczema, wildfire, summer sores,

rain rot, shear cuts, sunburn, and inflammation of the sebaceous glands; the effects of alkali dust may at times be mistaken for scab.

Treatment.—The only satisfactory treatment for scab is dipping. Hand dressing will not suffice and permits the spread of the disease while seeming to cure obviously affected areas. Animals must be dipped twice at intervals of 10 to 14 days, preferably 10, in warm dip. Ewes, bucks, and lambs should be dipped separately. Sheep must be held in the dip not less than two minutes; in the case of animals with advanced cases, especially in the fine-wool sheep, they should be held three to five minutes the first time, unless the crusts and scabs are first broken up and soaked with dip. The lime-sulphur dip and the nicotin-and-sulphur dip are the two dips recognized in official dipping for scabies.

Prevention.—Open pasture that has been used by scabby sheep should be regarded as dangerous for a month or two, and buildings are regarded as suspicious for a year or more. Keep sheep away from old bedding grounds and other infected areas. As regards buildings, pens, etc., it is advisable to abandon them, burn them, or else clean and disinfect thoroughly if they are to be used after having had scabby sheep in them. Stray sheep should be looked on with suspicion and goats may carry scab mites for long periods. Care must be used in purchasing sheep from areas where there has been any scab.

OTHER VARIETIES OF SCAB.

Head scab and foot scab in sheep are relatively rare diseases caused by species of mites different from those causing common scab. The same methods of treatment may be used, but head scab may prove more difficult to cure and four or five or more dippings, supplemented by local applications of remedies, may be necessary. In cases of head scab the interval between dippings should be shortened to a week or even to five days.

OTHER EXTERNAL PARASITES.

True ticks occasionally infest sheep, but in this country it is rare to find ticks present on sheep and we are fortunately free from ticks that habitually infest sheep. Among those that do occur on our sheep is the spinose ear tick.⁴ This is particularly prevalent in the Southwest. It enters the external canal of the ear and attaches there well below the hair line, sucking blood from the tender skin. The ticks enter the ear as 6-legged seed ticks, become engorged, grub-like larvæ, molt to form the 8-legged nymph, which is covered with numerous small spines, and after months spent in the ear the nymphs

⁴ *Otobius megnini* (*Ornithodoros megnini*). For additional information see Farmers' Bulletin 980 on "The Spinose Ear Tick and Methods of Treating Infested Animals."

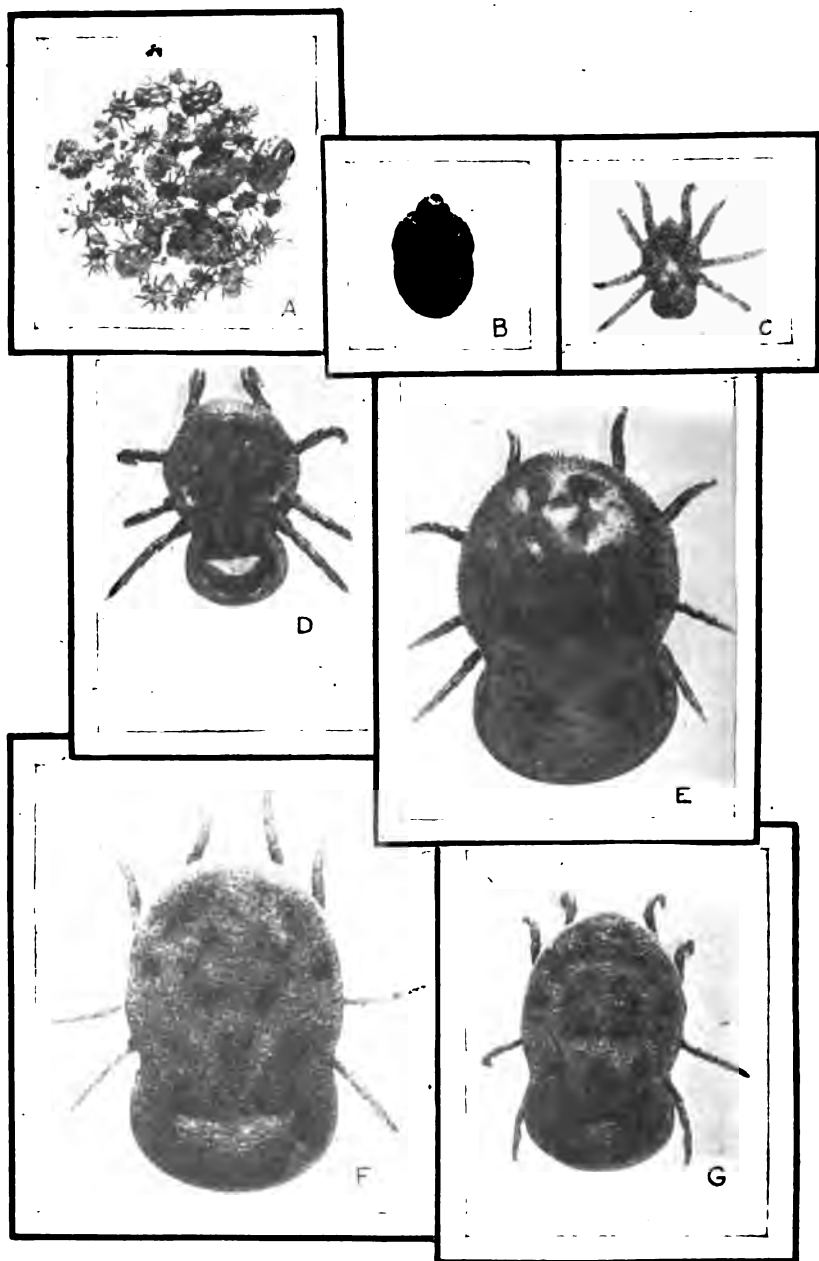


FIG. 8.—The spinose ear tick (*Otobius megnini*). A, ear ticks and debris from ear of cow (about natural size). B, engorged larva (magnified five times). C, young tick (magnified five times). D, partially engorged young tick (magnified five times). E, fully engorged young tick (magnified five times). F, adult female (magnified five times). G, adult male (magnified five times). (From Imes, 1918.)

crawl out, conceal themselves in dry protected places, transform into adult ticks, and mate (fig. 8). The female lays eggs which give rise to the 6-legged seed ticks and these in turn infest new hosts. Infested animals often have the ear canal plugged with wax and the excretions of the ticks. Such animals shake their heads or turn them from side to side. The ticks cause serious injury and occasionally death, especially among horses and cattle. The best treatment is to clean the ear canal with a wire loop, using care not to injure the animal, and inject into the canal a mixture of 2 parts commercial pine tar and 1 part cottonseed oil.

The screw worm^{*} is the name commonly given to the maggot of a sort of blowfly especially prevalent in the Southwest. It is especially apt to infest sheep recently sheared, getting into the fresh cuts, and in the same way attacks sheep and other animals that have been recently castrated, dehorned, or otherwise injured by having the skin broken. The fly is larger than the housefly (fig. 9), dark bluish-green in color, with three black stripes on the back between the wings, and with a red or reddish-yellow coloring in the face. It deposits its eggs in carcasses or in wounds, in masses of from 40 to 250 eggs. In wounds these eggs hatch in three hours or less, giving rise to young maggots which burrow into the wound and grow rapidly during a period of 4 or 5 days (fig. 10). They then leave the wound, burrow into the ground and form pupæ. The adult fly emerges from the pupal case in 3 to 14 days, the entire life cycle being 1 to 4 weeks.



FIG. 9.—Screw-worm fly, as seen from above. Much enlarged. (From Bishopp, Mitchell, and Farman, 1917.)

The best treatment for an infested wound is to pour in chloroform, later remove the maggots, wash with a suitable disinfectant, and apply pine tar to prevent fresh attacks. Probing and opening the burrows is regarded as inadvisable. When the wound is severe it is advisable to call in a veterinarian, as there is sometimes serious

^{*} *Cochliomyia macellaria* (*Chrysomya macellaria*). For additional information see Farmers' Bulletin 857 on "Screw-Worms and Other Maggots Affecting Animals."

danger from hemorrhage and infection. Every year numerous animals die from screw-worm infestation.

By way of prevention it is essential that carcasses of animals dying from any cause should be promptly burned or otherwise disposed of so that flies can not breed in them. If they are buried they should be buried in quicklime and the entire carcass should be at least two feet under ground and the soil tightly packed. Shearing cuts and other injuries from accident or operations should be coated with pine tar to prevent flyblow. Flytraps are valuable as control measures.

Sheep-wool maggots belonging to a number of species⁶ are somewhat similar in habits to the screw-worm fly. Related flies have become a very serious pest to sheep in Australia. The flies deposit their eggs or young in the wool. Infested sheep are sometimes treated by clipping the wool about infested parts and applying concentrated dip,



FIG. 10.—Screw-worm maggot, side view. Enlarged. (From Bishopp, Mitchell, and Parman, 1917.)

chloroform, or mixtures of turpentine and tar. It is also advised that lambing should occur as early as possible and shearing be carried on before the warm

weather sets in, to reduce the chance of infestation. The wool of sheep, especially those affected with diarrhea, should be kept trimmed about the tail region to prevent flyblow at this place. A practice which has been found of considerable value in Australia consists in spraying the tail region of the sheep with 0.2 per cent solution of arsenious oxid just before lambing time. This can be done quickly and easily, is cheap, and affords considerable protection. The prompt destruction of carcasses is as important in the control of these maggots as it is in the control of the screw worm.

INTERNAL PARASITES.

The internal parasites include tapeworms, flukes, roundworms, and a few other forms, such as the maggots causing grub in the head, the tongue worm, and the one-celled forms, or Protozoa, these last being microscopic in size and of comparatively little known importance in the United States so far as sheep are concerned.

The following discussion includes the more important of the numerous kinds of internal parasites that infest sheep.

⁶ *Phormia regina*, *Lucilia sericata*, and others.

ARTHROPODS.

The arthropods include certain forms that live during a portion of their life as internal parasites of sheep, though most of the arthropod parasites of sheep are external parasites.

The arthropods are forms which possess 6 or more leglike appendages, such as the insects, which, in a limited sense of the word, include those forms with 6 legs, the spiders and spiderlike forms, which as adults have 8 legs, and other forms having more than 8 legs, some of them having a considerable number.

The life history of the arthropods varies so greatly in the case of different forms that it is hardly possible to give a general statement covering it.

GRUB IN THE HEAD.⁷

Location.—The grubs occur in the nostrils and in such communicating cavities as the frontal sinus and the maxillary sinuses, cavities in the upper jawbone.

Appearance.—The parasites appear as maggots which at first are less than 2 mm. (one-twelfth of an inch) long. When fully developed in the sheep, they are usually over 2 cm. (four-fifths of an inch) long and 7 mm. (almost one-third of an inch) wide, though the grub may contract or expand to a smaller or greater dimension. There are 11 segments, rather flattened on the ventral (lower) surface and arched on the dorsal (upper) surface. The ventral surface is spiny, the dorsal smooth. At first the grubs are white, later they become yellowish and darker, a band appearing on the dorsal side of the segments, and finally becoming black (fig. 11). At the head end are two large hooks and at the tail end are two rounded breathing pores.



FIG. 12.—Adult fly which causes grub in the head (*Eristalis aeneus*). (From Curtice, 1890.)

Life history.—The adult fly (fig. 12), which looks something like an overgrown housefly, is active during the summer, usually in June and July. The female fly deposits a tiny grub on the edge of the sheep's nostril. Sheep usually run when the fly attacks them

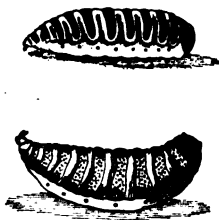


FIG. 11.—Grub in the head (*Estrus ovis*). Above, normal position; below, grub turned on its back. (From Osborn, 1896, after Riley.)

⁷ *Estrus ovis*.

or is seen by them, often becoming frantic and holding the nose in the dust or against other sheep. The attack occurs usually during the heat of the day, the fly being quiet in the early morning and late afternoon. The grub migrates up the nostrils by means of its hooks and spines, and may make its way to the communicating cavities. Occasional grubs fail to leave the sinuses in time and become too large to get through the apertures they entered; these die and usually become calcified. The grub in the sinuses feeds and grows until it is ready to leave the sheep. Sometime during the spring or summer, in temperate climates, the grubs leave the sheep and fall to the ground, into which they burrow a short distance. Their skin becomes hard and leathery and they lie quiescent for three weeks to two months, according to conditions of temperature and moisture. Finally the adult flies break out from the leathery envelopes within which they have undergone their transformation from the preceding stage, like a butterfly in a chrysalis, crawl to the surface, and are ready to mate and then to deposit their young.

Distribution.—This parasite appears to be prevalent throughout the United States wherever sheep are kept. It is a common and troublesome pest, especially in the South.

Symptoms and lesions.—As the grub crawls about in the nostrils the hooks and spines set up an irritation which is at first acute with a resultant flow of serum from the nose, resembling a "cold in the head." Presently the nostrils show evidence of bacterial infection, the flow thickens and becomes discolored, presenting the picture called by the sheepmen "snotty nose," a pronounced catarrhal condition. The hooks and spines set up minute hemorrhages, which are visible on post-mortem examination as rows of blackened dots on the mucous lining of the nostrils and sinuses. One result of this irritation and inflammation is a thickening of the mucous membrane, a condition which interferes with its normal function of smell and helps to close the breathing passages, which are already functioning improperly as a result of the thick, catarrhal secretions. As a consequence the sheep experiences difficulty in breathing, which tends to impair its general physical condition. Add to this the fact that the sinuses may become filled with purulent matter and that the toxins from the purulent matter here and elsewhere are constantly absorbed and there is evidently present a condition which must weaken an animal. Furthermore, the irritation due to the wandering of these spiny grubs over the sensitive mucous membrane of the nostrils prevents the sheep from resting or devoting its full time and energy to feeding and growing.

Though the characteristic symptom of grub in the head is the profuse discharge from the nose, the sheep show other evidences of

the infection. They sneeze frequently and often show symptoms of difficult breathing. The eyes become inflamed, as would be expected in connection with an inflammation of the nostrils, the head is often carried low or may be moved about in a peculiar manner as though the sheep were trying to rid themselves of an obstruction in the head, the appetite is diminished, or at least the sheep eat less owing to distraction from pain and difficult breathing, and in severe cases the animals may have convulsions and ultimately die.

Treatment.—The treatment for this condition is not very satisfactory and dependence should be placed on preventive measures, which are, fortunately, of a comparatively simple sort and easily applied. One of the measures which has been advocated in the way of treatment is to put the sheep in an inclosure on hard ground or on a floor of some sort which has been sprinkled with lime, and to mill them around so as to stir up the lime and cause violent sneezing, in the hope of expelling the grubs in this manner. This may remove some grubs from their position in the nostrils, but it can have no effect on those in the sinuses and will by no means remove all those in the nostrils. Attempts have been made to kill or remove grubs by putting the sheep in a room with burning sulphur, some person remaining there as long as possible to test the strength of the fumes. This is dangerous to the sheep and the operator and can not be recommended, especially since it is not very successful. In the case of particularly valuable animals which are seriously affected, the sinuses may be opened with a trephine and the grubs extracted with forceps. Sheep tolerate the operation well enough, but the operation is one that is suitable only for trained and skilled operators and should be done by a competent veterinarian. If the sheep is not worth the cost of such an operation, it should be sent to the butcher before the progress of the disease has rendered the animal unfit for food.

Prevention.—Smearing the nose of the sheep with a preparation that will prevent the fly from depositing its larvæ successfully on the nostril has been found to be a very satisfactory preventive measure and is one that is extensively practiced. Various preparations have been used, such as equal parts of tar and grease, of tar and fish oil, or of tar and whale oil; but the use of pine tar alone seems to be quite satisfactory. It is advisable to apply the tar by hand, at least the first time, and to make sure that it is applied liberally to the entire margins of the nostrils. The application may be renewed by hand later, as often as necessary, or may be automatically renewed by using a salt lick consisting of a thick plank or split log in which holes, 2 inches in diameter, are bored, with salt placed in the holes and the edges of the holes heavily tarred, so that the sheep get the tar on their nostrils as they lick the salt.

TAPEWORMS.

Adult tapeworms are usually composed of a head, armed with hooks and suckers as a rule (though those in the sheep's intestines have no hooks), and a body consisting of a number of flat segments arranged in a chain. Adult tapeworms are usually found in the small intestines, but in some cases they may occur in the stomach, large intestines, or the ducts of the liver and pancreas. Tapeworms produce eggs of microscopic size which pass out in the feces and which on being swallowed by a suitable host, usually of a sort different from the host of the adult tapeworm, give rise to an intermediate stage, or larva, which is usually more or less spherical or elliptical and composed of a tapeworm head and neck attached to a membrane, the membrane usually inclosing a clear fluid. In the case of many of the common tapeworms this form is called a bladderworm. It usually occurs in the body tissues, and when these are eaten by the host of the adult tapeworm the head of the tapeworm passes to the intestine and forms the adult worm by the addition of segments back of the head. This tapeworm in turn produces eggs and the cycle is repeated. Thus, certain tapeworms in the dog give rise to certain bladderworms in sheep, the tapeworm eggs in the feces of the dog being deposited on the pasture and picked up by sheep with the herbage that they eat. The dog in turn becomes infested with tapeworms when it eats the bladderworms in the meat, brain, liver, entrails, or other parts of the sheep.

Sheep may harbor adult tapeworms in the intestine and bladderworms in the body tissues.

THE MONIEZIAS.*

Location.—These tapeworms are found in the small intestines.

Appearance.—They are whitish to yellowish in color and may attain a length, in some specimens, of several yards (see fig. 13). The individual segments of a worm are broader than long, and each segment contains at some period of its development a complete set of reproductive organs. The end segments are full of eggs, and these segments break off from the rest of the worm and pass out in the manure, where they are often found by the farmer and regarded as complete worms. The presence of these segments in the feces serves to diagnose cases of infestation with the tapeworm.

Life history.—The life history of these tapeworms is not known. Sheep are herbivorous animals and would only by accident eat animals, such as insects, that might serve as intermediate hosts. It is probable that the intermediate hosts are small animals, such as insects, that are taken in by the sheep on grass, but we have no evidence on this subject.

* *Moniezia expansa*, *M. trigonophora*, and *M. plantestina*.

Distribution.—These tapeworms are more or less common throughout the United States. Two of the forms (*M. expansa* and *M. planissima*) are also widely distributed outside the United States.

Symptoms and lesions.—When these worms are present in sheep in large numbers they cause obstruction of the intestine and intestinal irritation, with the result that they interfere with digestion and the sheep become unthrifty, weak, and emaciated; such sheep are unable to stand adverse conditions, such as bad weather or poor food, and die where sheep not so infested may survive. The digestive derangement is manifested by diarrhea as a rule. It is known that tapeworms often cause very marked and even severe nervous symptoms in man, and while such symptoms are more difficult to detect in sheep, there is every reason to suppose that they may occur.

On post-mortem examination of affected sheep the tapeworms are found in the small intestine, often in large numbers. The sheep show no special indications of their presence other than poor condition, evidences of diarrhea, and inflammation or catarrh of the intestines.

Treatment.—There are no well-established treatments for tapeworms in sheep. Among the remedies which have been used are the following:

Kamala.—This drug has been given in doses of 1 dram to lambs. It causes diarrhea and lambs so treated may remain poor for some time in spite of abundant food and good conditions otherwise.

Koussou.—This is said to have given good results in doses of 2 drams to lambs.

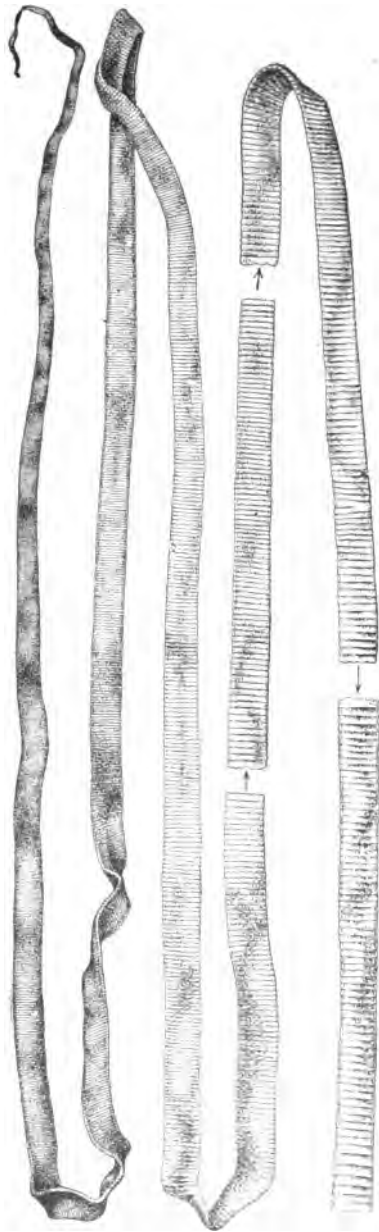


FIG. 13.—Tapeworm (*Moniczia trigonophora*). About natural size. (From Stiles, 1898.)

Koussin.—This is reported as giving good results in 2-grain doses. It expelled the tapeworms, and the animals remained in good spirits and improved in condition.

Oleoresin of male fern.—This is given in doses of 1 dram and may be given with 2 to 4 ounces of castor oil.

Areca nut.—This may be given to lambs in doses of 1 to 3 drams. It must be freshly ground shortly before being used, preferably the day it is used.

The copper-sulphate treatment for stomach worms, given on pages 39 to 41, will also remove tapeworms.

In South Africa good results have been reported from the use of a mixture containing 1 part of sodium arsenite (testing 80 per cent arsenious oxid) and 4 parts of copper sulphate. The total dose of the mixture is as follows: For animals 2 to 4 months old, 180 milligrams; 4 to 6 months old, 250 mg.; 6 to 10 months old, 375 mg.; 1 year old, 500 mg.; 2 years old or older, 625 mg. This may be given as a powder. Remove food and water the afternoon before dosing: dose the following morning; allow food that afternoon and food and water the next morning. The dose may be repeated the day after the first dose, in which case food is allowed the afternoon after the first dose, the animal is dosed the following morning and fed that afternoon, but no water is allowed from the afternoon preceding the first treatment until the morning following the second treatment. Owing to the poisonous nature of arsenic, it is best to test the treatment on a few sheep to be sure the dose is safe before dosing a flock, and the drugs should be kept out of reach of children and animals. If the treatment is repeated at intervals of a month or more through warm weather, the single treatment should be used.

The Oklahoma experiment station claims very good results from a solution containing 1 per cent copper sulphate and 1 per cent by weight of snuff or powdered tobacco. The tobacco is steeped overnight and the copper sulphate then added. The dose is 50 mls (about 1½ ounces) for lambs and twice this amount for full-grown sheep.

Prevention.—No dependable preventive measures against these tapeworms can be recommended, owing to the fact that the life history is unknown.

THE FRINGED TAPEWORM.⁹

Location.—This tapeworm is found in the small intestine, the gall ducts, gall bladder, and biliary canals of the liver, and in the duct of the pancreas.

Appearance.—These are whitish or yellowish tapeworms and may be a foot long (fig. 14), but are commonly shorter. They may be readily distinguished from other tapeworms by the fact that each

⁹ *Thysanosoma actinoides*

of the segments has a fringe on its posterior border. This fringe may be most easily seen when the segment is put in water, where the fringes can float out from the segment. Tapeworms found in the liver or pancreas will be this worm and not the *Moniezia*s already described.

Life history.—As in the case of the *Moniezia*s (and this is true of all the adult tapeworms of cattle, sheep, and horses), the life history is unknown. Presumably it has an intermediate stage, probably in an insect or other small animal.

Distribution.—The fringed tapeworm is a parasite of western sheep and is found in the East probably only when the sheep have been shipped from the West. The infected range is probably confined to North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas, and the States west of these. The parasite apparently has found conditions most favorable among range sheep, and it seems to be losing ground with the breaking up of the big western sheep ranges and the substitution of small holdings of sheep.

Symptoms and lesions.—The obstruction of the bile ducts and pancreatic ducts causes inflammation of these ducts and derangement of the liver. As a result there is an alteration in the secretions as regards amount and character, which impairs digestion and causes a lack of thriftiness. This shows in lost flesh and poor quality of flesh and wool. Sheep weakened by fringed tapeworms may die from the parasitic infestation or from inability to withstand other adverse conditions. Infested sheep are commonly hidebound and suffer from diarrhea.

On post-mortem examination the tapeworms may be found in the intestine and in the liver and pancreas, and the ducts of these glands are usually found thickened when infested. In the spring of the year fringed tapeworms seem more likely to be found in the small intestine than at other seasons.

Treatment.—No successful treatment is known for this parasite. Such treatments as have been attempted have failed, and all that can be recommended at this time is careful nursing and good feeding.

Prevention.—As in the case of the *Moniezia*s, the fact that we do not know the life history of this worm makes it impossible to give specific directions for preventing infestation.



FIG. 14.—Fringed tapeworm (*Thysanosoma actinioides*.) About natural size. (From Stiles, 1898.)

BLADDERWORMS.

THE THIN-NECKED BLADDERWORM.¹⁰

Location.—The thin-necked bladderworm is found in the abdominal cavity attached to the mesenteries or omenta or in the liver.

Appearance.—The bladderworm looks like a sac full of a clear fluid, with a white object, which is the head and neck, projecting into it from one end. It is usually about 1 inch in diameter, but may attain a long diameter of several inches. The bladderworm proper is surrounded by a cyst, which is developed by the host animal as a protective measure against the parasite. When this cyst is broken the parasite usually rolls out and is seen to be a thin-walled structure. By careful manipulation the head and its rather long neck may be squeezed out at one end of the "bladder" (fig. 15).

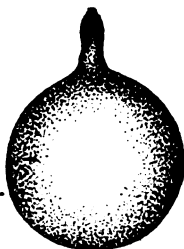


FIG. 15.—Thin-necked bladderworm (*Cysticercus tenuicollis*). Natural size. (From Stiles, 1898.)

Life history.—If one of these bladderworms is fed to a dog the cyst wall will digest, but the tapeworm head and neck will pass on to the small intestine of the dog and begin to grow segments back of the neck. In this way it will form a tapeworm, one of the largest of the dog tapeworms¹¹ (fig. 16). This tapeworm attains a length of a yard or more, becoming mature and beginning to liberate egg-bearing segments in the course of 10 or 12 weeks. When

dogs infested with these tapeworms run over pastures used by sheep, they leave feces containing the tapeworm eggs on the pastures, and these eggs are spread by rain and washed on to the grass and into streams and puddles where the sheep drink. When the sheep get these eggs in food or water, the embryo escapes from its surrounding shell, makes its way to the liver of the sheep, and begins to develop. In time it slips out of the liver and becomes attached to the mesenteries or omenta. At first it is a bladder without a head, but later the head and neck develop, and it is then ready to infect any dog that eats it.

Distribution.—This parasite is quite generally distributed over the United States, but the indications are that the worm is becoming less common as a result of improvements in disposal of viscera and offal at slaughterhouses during the last 15 years: It is most likely to be present where sheep are associated with dogs, either when herded by them or where stray dogs are common, and where sheep are slaughtered on farms or at small country slaughterhouses at

¹⁰ *Cysticercus tenuicollis*.

¹¹ Commonly called *Tania marginata*, and more properly *Tania hydatigena*.

which little care is exercised in disposing of the viscera and of diseased portions of carcasses.

Symptoms and lesions.—Light infestations with these bladderworms seem to do very little damage. Severe infestations, such as a sheep would get by eating grass that had an entire segment full of eggs on it, will make a sheep very sick and may kill it. Under these conditions sheep usually die at a rather early stage of the disease, and at a time when the embryos are wandering around in the liver, the immediate cause of death being hemorrhage from the liver, or peritonitis. Post-mortem examination under these conditions would seldom be sufficiently minute to reveal the exact cause of the trouble, and it would seldom be charged to the account of this parasite.

On post-mortem examination the bladderworms are usually readily observed in the mesenteries or omenta, or in earlier stages, in the liver. When the liver has just recently been invaded, the presence of the parasite is usually indicated by serpentine markings showing the course of the wanderings of the young worms.

Treatment.—There is no treatment for infestation with the bladderworm in sheep.

Dogs should be kept free from tapeworms of any sort, including the one responsible for this bladderworm in sheep. For removing these tapeworms, fast the dog from noon of one day until the following morning and then give one of the following treatments:

Oleoresin of male fern.—The dose for dogs is 15 minims to 1 dram (a quarter of a teaspoonful to a teaspoonful), according to size. This may be given in capsules and followed immediately by an ounce of castor oil.

Areca nut.—This may be given in the same amounts as the oleoresin of male fern, and will usually not need a purgative, as

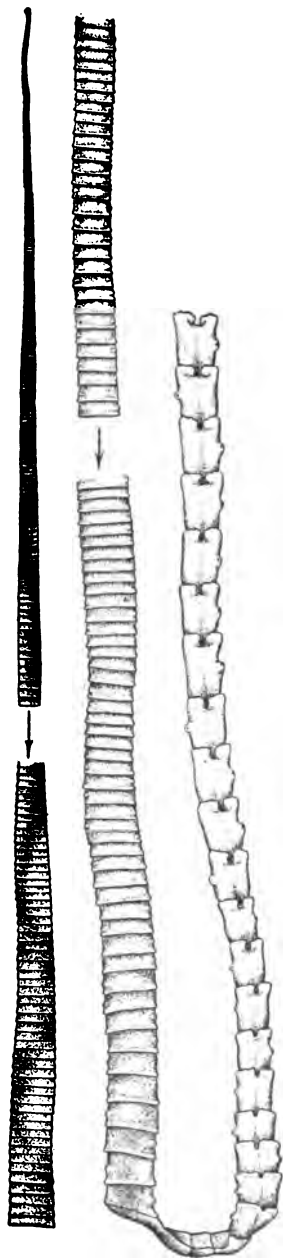


FIG. 16.—Tapeworm (*Tania hydatigena*) of dog, developed from thin-necked bladderworm of sheep. About natural size. (From Stiles, 1898.)

areca is itself purgative. If feces are not passed in the course of four or five hours, it is advisable to give castor oil or some other purgative. As noted previously, areca nut must be freshly ground to be efficacious.

Kamala.—This may be given in doses of half a dram to 2 drams (a half teaspoonful to 2 teaspoonfuls). The powder may be given in sirup and will not need to be followed by a purgative, as kamala itself is a purgative. As in the case of areca nut, if feces are not

passed in four or five hours castor oil or some other purgative should be given.

Any tapeworms that are passed and the feces with them should be burned. On the farm this is easily done by using hay or straw for fuel.

Prevention.—This consists in preventing dogs from eating uncooked meat, especially diseased and parasitized meat and viscera. Slaughterhouse refuse should be tanked and not left where dogs can have access to it. The use of the



FIG. 17.—Sheep muscle showing measles (*Cysticercus ovis*). Natural size. (From Ransom, 1913.)

tank has apparently resulted in a diminution in the number of cases of this parasite in sheep and dogs, and the extension of this measure will probably eradicate it in time. Dogs should be kept free from tapeworms by suitable remedies, whenever necessary, and it would be advisable to give such treatment as a routine procedure about four times a year where there is any chance of dogs eating infective material. Stray dogs should be kept off farms and suppressed by appropriate measures.

SHEEP MEASLES.¹²

Location.—Parasites known as sheep measles occur in muscles, including the heart, and intermuscular connective tissue, and as degenerate cysts in the lungs, walls of the first and fourth stomachs, and the kidneys.

Appearance.—This parasite occurs in the meat (measly mutton) as oval cysts 3.5 to 9 mm. (one-seventh to one-third of an inch) long by 2 to 4 mm. (one-twelfth to one-sixth of an inch) wide. These cysts have a thin external membrane inclosing a clear fluid. On

¹² *Cysticercus ovis*.

one side of the cyst is an opaque white object, which is the head and neck of a tapeworm (fig. 17). When degenerated the cysts appear as cheesy or hard nodules, the hardness being due to lime salts.

Life history.—The life history of this parasite is similar to that of the thin-necked bladderworm, the adult being a certain species of tapeworm of the dog (*Tænia ovis*).

Distribution.—In the United States this parasite appears to be most common in the West, especially in Montana, Idaho, Washington, Oregon, California, Colorado, and Nevada. It has been found abroad in England, France, Germany, Algeria, German Southwest Africa, New Zealand, and South America.

Symptoms and lesions.—When sheep have but a few of these cysts no symptoms are likely to be observed, although it has been suggested that sheep measles may be responsible for the many stiff lambs found during spring and summer on the western sheep ranges. When many cysts are present sheep will become very sick, and if all the eggs from one segment are eaten the sheep are likely to die. On post-mortem examination the cysts are the principal thing observed, though in badly infested cases the meat may be watery and discolored.

Treatment and prevention.—These are the same as for the thin-necked bladderworm (pp. 25 and 26) and its adult tapeworm.

THE GID PARASITE.¹³

Location.—The gid parasite occurs in the brain or spinal cord. Degenerate cysts that failed to reach the central nervous system may be found in muscles and other tissues.

Appearance.—This worm occurs as a large cyst or bladderworm, attaining the size of a hen's egg or larger, and is composed of a thin membrane containing a rather large amount of fluid. On the bladder membrane are a number of small white objects about the size of a grain of wheat, projecting, as a rule, into the bladder fluid (fig. 18). These are the tapeworm heads. A parasite of this sort is called a cœnurus.

Life history.—When such a bladderworm, or cœnurus, is eaten by a dog or coyote the bladder membrane digests, releasing the attached tapeworm heads. These heads then pass into the small intestine, where they form the adult tapeworm by the addition of segments back of the head (fig. 19). Ordinarily the worm is fully grown and 2 or 3 feet long in the course of a month or two, though occasionally a longer period is required. The full-grown tapeworm produces minute eggs, which pass out in the feces of the dog on to the pasture or range. Under favorable conditions these eggs are taken in by sheep with contaminated food or water. The shell

¹³ *Multiceps multiceps*, Synonym, *Cœnurus cerebralis*.

digests from the egg and releases an embryo, which is armed with six hooks. By means of these hooks the embryo cuts its way through the tissues of the sheep and into the blood stream. In the blood the embryos are carried to various tissues, but only those that reach the brain or spinal cord are able to attain the full larval development, the others dying and degenerating by the time they reach the size of a pea. Those that reach the central nervous sys-



FIG. 18.—Gid parasite (*Multiceps multiceps*) from brain of sheep. Natural size. (From Hall, 1910.)

tem at first move about on or in the brain or spinal cord, forming curving channels. At a suitable point the wandering ceases and the bladderworm grows and completes its development in about seven or eight months, the sheep dying in nine months or earlier.

Distribution.—In the United States this parasite has been found chiefly in northern Montana, where it has been established for about 30 years, possibly longer. There have also been outbreaks of gid in Arizona and in New York. Cases have been observed also in various

localities to which sheep have been shipped from infested regions. Occasionally cases are imported from Europe. Outside the United States the disease is known to occur in England, Scotland, Ireland, France, Germany, Austria, Hungary, Italy, Sardinia, Switzerland, Greece, Spain, Holland, Denmark, Iceland, Shetland, Morocco, Cape Colony, German Southwest Africa, South Australia, New Zealand, Argentina, Chile, and Canada.

Symptoms and lesions.—At the time that the young worm gets to the brain there are usually slight symptoms of fever and restlessness, which are easily overlooked. If the sheep dies at this time, as a result of severe infestation, an examination of the brain will show a number of curving channels on its surface. As a rule the symptoms of this stage abate and there is no further indication of the presence of the parasite until it has grown to the point where the heads form. This will take place about the seventh or eighth month after infection. The head of the worm can be evaginated from the bottom of its tubular neck, just as a glove finger may be turned inside out, and this brings its hooks and suckers into contact with the brain. From this irritation and from the pressure of the growing bladderworm there arise the very striking symptoms indicative of gid. Affected sheep very commonly walk in a circle, turning toward the side corresponding to the affected portion of the brain when the parasite is on the surface of the cerebrum. When the parasite

is located at other points the symptoms are somewhat different. In these cases sheep may walk with the head held high and may step high, or with the head held low and with a stumbling gait, or may show other odd symptoms in the way of unusual locomotion. Such animals gradually lose interest in food and water and finally cease eating or drinking. In consequence they become very much emaciated. They may move about continuously or stop at times and gaze fixedly at nothing in particular. They are difficult or impossible to herd and tend to lag behind the flock or become lost. The

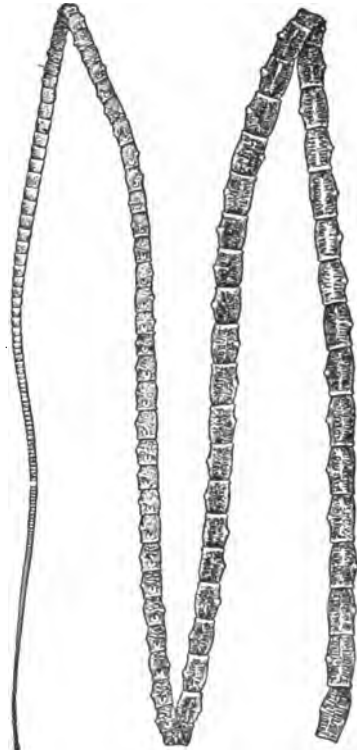


FIG. 19.—Tapeworm stage of *Multiceps multiceps* in dog. Actual size. (From Hall, 1910.)

head is often carried to one side and the animal may become blind or appear to be blind.

Unless surgical treatment or accident frees the sheep from its parasite, the animal will die, usually in the ninth month. When examined after death, the brain or spinal cord will be found to have on or in it a bladderworm, or more than one, and an equal amount of brain or cord tissue will be found to have disappeared or been crowded aside by the growth of the cyst. The skull adjacent to the parasite is often softened or even absorbed to the point where it has a hole or several holes through it. In the late stages sheep are so emaciated that the meat is unfit for food.

Treatment.—The treatment for gid is surgical. This is satisfactory only when the cyst is on the surface of the brain. Operation may be performed with a trocar and cannula or with a trephine. In the trocar and cannula operation the wool is sheared over the affected area, as determined by the symptoms and by palpation to find a soft spot or one where the sheep reacts violently to pressure. Under local anesthesia the trocar and cannula are driven through the skull and the trocar withdrawn from the cannula. If the cyst is struck, a watery fluid will issue from the cannula. This fluid is syringed out and the cannula withdrawn. Suitable cannulas are provided with a cleft to catch the bladder membrane and pull it out. If this fails, it is necessary to remove the membrane with forceps or by some other means. This operation, like operations generally, should be conducted under aseptic conditions. The median line of the skull should be avoided.

With the trephine outfit the wool is sheared over the proper area and under local anesthesia and aseptic conditions a V-shaped incision is made through the skin and the skin dissected back. A piece of skull is then cut out with a five-eighths-inch trephine and the hard membrane covering the brain is cut with bent scissors. The parasite will usually push out and may be grasped with forceps and removed. If it does not appear, it may be necessary to explore for it with the finger. After removing the parasite and controlling the hemorrhage, the skin flap may be sewed back along one side of the tip of the V, and the wound covered with a pledget soaked in some antiseptic. The animal should be kept quiet in a dark shed for several days after operation.

Some sheepmen cut the skull with a pocket knife or puncture the cyst with a knife. In such cases the sheep is apt to die of infection, even if the worm is removed. The operation for gid calls for care and should be performed by a competent veterinarian. If operation does not seem to be feasible, it is advisable to kill giddy sheep for mutton or send them to market before they become emaciated and unfit for food.

Prevention.—The most important preventive measure is to destroy the heads or at least the brains of giddy sheep. This may be done by burning. Where wood is scarce the skull may be split with an ax or cleaver and the brain put on a forkful of hay or straw and burned. Where this is not feasible the brain may be removed from the skull, crushed, and covered with formaldehyde, turpentine, or a coal-tar or tobacco dip. The essential thing is to destroy the parasite and prevent dogs, coyotes, or other animals from eating it.

Another measure of importance is to keep dogs, especially sheep dogs, free from tapeworms. To this end it is advisable that they be given tapeworm treatment four times a year. For the treatments that may be used see page 25. Measures against coyotes and other noxious wild animals are valuable in controlling gid as well as in keeping down the destruction of stock. Stray dogs should be eliminated on the same grounds.

THE HYDATID.¹⁴

Location.—The preferred sites of the hydatid parasite in sheep are the liver and lungs, but it may occur in practically any organ or tissue.

Appearance.—The parasite occurs in sheep usually as a multiple bladderworm, varying from the size of a nut to the size of a child's head, sometimes as a spherical object and sometimes irregular in shape (fig. 20). It has a very thick, laminated bladder wall, and in the simplest form of the parasite this bladder contains a clear fluid and minute objects resembling grains of sand lying unattached in the fluid. These grains are brood capsules, and each of them contains a number of very small tapeworm heads. Sometimes the bladderworm develops other bladderworms, attached or unattached, on the inside or outside.

Life history.—When the brood capsules from a hydatid are eaten by a dog, cat, or other suitable animal, each tapeworm head in the brood capsules develops into a tapeworm by the addition of segments back of the head. This tapeworm is a very small one, less than half a centimeter (about one-fifth of an inch) long (fig. 21). As the hydatid may form thousands of such heads in its brood capsules, dogs may become infested with large numbers of these worms on eating hydatids. The eggs produced by the adult tapeworms in the dog pass out in the feces. When taken in by a sheep or other animal the egg hatches and releases an embryo which makes its way to some



FIG. 20.—Hog liver infested with hydatid (*Echinococcus granulosus*). Greatly reduced. (From Stiles, 1898.)

¹⁴ *Echinococcus granulosus*.

suitable tissue and develops to the hydatid. This hydatid may develop in man if an egg of the tapeworm is swallowed, and a large percentage of hydatid infestations in man result in death. It is therefore a very dangerous parasite to human beings.

Distribution.—This parasite has been found at a number of places in the United States proper and in Alaska, as well as in other parts of the world. Certain regions are found to send a large number of infected swine to the slaughterhouses, though its occurrence in sheep is comparatively rare in the United States.

Where it is locally prevalent, its abundance may be attributed to infected dogs which have probably become infected through carelessness in the disposal of diseased carcasses and viscera of slaughtered animals. Careless persons may feed diseased portions of carcasses to dogs or leave them where dogs will get at them and eat them.

Symptoms and lesions.—The symptoms in sheep affected with hydatid depend on the location of the parasite and its size, and so are very variable. Where the parasite is small or has room to develop without crowding important organs, few symptoms may be noticed. On the other hand, the parasite may develop in such structures as the brain or heart and cause very marked symptoms and sudden death from pressure or rupture. As a rule, infestations will not be detected and correctly diagnosed during the life of a sheep and they will be found only

on post-mortem. In such cases the large, thick-walled bladders are readily found.

Treatment.—The only treatment for this condition is surgical, and this is not apt to be feasible in sheep, even if the disease should be diagnosed ante-mortem.

Prevention.—The most important measure in the way of prevention of this disease is the proper disposal of carcasses and portions of carcasses of animals dying on the farm or killed there or elsewhere. The "condemned" tank at the modern slaughterhouse has been one of the greatest factors in destroying parasites of this sort, and the lack of an equally good arrangement at the small country slaughterhouse and on the farm is one of the important conditions which permit such parasites to persist. Where diseased viscera, such as livers infested with hydatid, are thrown out where dogs can get at them, parasites of this kind are liable to be prevalent. The next measure of importance in controlling this disease is to keep dogs free from



FIG. 21.—Hydatid tapeworm (*Echinococcus granulosus*). Highly magnified. (From Stiles, 1898, after Leuckart.)

tapeworm by administration of tapeworm treatments four times a year. For these treatments, see page 25.

FLUKES.

Flukes are usually flat, leaflike animals, provided with suckers, but not segmented like the tapeworms. They occur in the adult stage in various locations, the stomach, intestines, liver, lungs, blood vessels, and may occur in immature stages in such tissues as the muscles. The adult flukes produce eggs of microscopic size which pass out and hatch in water. The embryos released from the eggs infect snails in which they transform into a succession of larval stages. The parasites finally escape from the snails and may penetrate the skin of the final host or may be swallowed, sometimes after encysting, in food or water.

Sheep in certain localities in the United States, as well as in other parts of the world, suffer considerably from fluke infestation. The common liver fluke and the large liver fluke occur in American sheep.

THE COMMON LIVER FLUKE.¹⁵

Location.—These flukes are found usually in the biliary canals and the ducts of the liver, though they may occur as wandering parasites in the lungs and elsewhere.

Appearance.—The common liver fluke is a flattened, leaflike, brown animal, usually about an inch long (fig. 22). There is a sucker at the anterior, or front, end, on a cone-shaped extension, and just behind this is a ventral sucker. Through the skin or cuticula covering the animal one can see the branching intestine and the uterus filled with eggs.

Life history.—The eggs produced by the adult flukes pass out in the feces and on getting to water release a ciliated embryo. This embryo attacks certain species of snails and on entering the snail undergoes certain changes, which in time give rise to a form called a cercaria. This is like a small fluke, provided with a tail by means of which it swims about. Finally it loses the tail and encysts. The encysted cercariæ may float about on or in water or may be attached to grass blades or other vegetation. When these are swallowed by sheep, or other suitable host animals, the larval flukes escape in the digestive tract and bore their way through the intestinal



FIG. 22.—Common liver fluke (*Fasciola hepatica*). Natural size. (From Stiles, 1898.)

¹⁵ *Fasciola hepatica*.

walls to the body cavity. Here they wander over the surface of the viscera and the walls of the body cavity and as a rule finally perforate the capsule of the liver and reach the extremities of the biliary canals. A few go astray and perforate the diaphragm, getting to the lungs. In the liver the young flukes grow and make their way down the canals, the larger ones being found in the bile ducts, and begin again the life cycle with the formation and passage of eggs.

Distribution.—This parasite occurs over a large part of the world, where low, wet pastures and the presence of suitable snails make it possible for it to exist. In the United States it occurs on the Atlantic and Pacific coasts in places, and along the Gulf of Mexico. In these regions it occurs in wet pastures, especially along rivers and tributary streams. The States in which the fluke is most prevalent are Washington, Oregon, California, Texas, Arkansas, Louisiana, Alabama, and Florida. It is also prevalent in Porto Rico and Guam.

Symptoms and lesions.—Sheep are likely to put on fat and seemingly improve in condition in the early stages of liver-fluke disease, usually in the summer and fall, apparently as a result of a stimulation of the functions of the liver. Later, however, they lose in condition. The skin and mucous membranes are paler and the animal is less lively. The animal feeds less and ruminates less. Edema appears as the composition of the blood is altered, and may be seen as swellings along the pendant portions of the body, for example, in the region under the jaw. During the winter the sheep becomes leaner, breathes rapidly and feebly, and is dejected. A diarrhea is usually present at a late stage of the disease.

Animals may die at any stage of the disease, but if they survive the attack the flukes leave the sheep in the spring and a part of the damage is repaired. Total recovery is hardly possible, as the liver is burdened with scar tissue in the areas where the flukes have been. The disease may be diagnosed from its symptoms, if one is familiar with it, but a safer diagnosis is based on the finding of the worm eggs in the sheep manure.

For the purposes of the farmer and sheepman the surest diagnosis is made by killing a sick sheep and making a careful post-mortem examination. If the ducts of the liver are carefully slit and examined, the flukes will be found as dark, leaflike objects which, if watched a short time, will show movement. The liver may be washed in a plentiful supply of clear water as it is cut up, and the water examined for the flukes that may wash out. The liver of infected sheep is softened and roughened, and may show channels under its capsule. In old cases puckered scar areas are present.

The softening of the liver is what gives the name of "liver rot" to the disease. The biliary canals and gall ducts are much thickened and enlarged and often are marked by ridges on the surface of the liver.

Treatment.—The two remedies which have been found satisfactory are male fern and kamala. According to some writers, however, kamala is much less efficacious than male fern.

Oleoresin of male fern is administered as follows: Give by mouth 3 to 5 grams of the male fern (from $\frac{3}{4}$ of a teaspoonful to $1\frac{1}{4}$ teaspoonfuls), according to the size of the sheep, in 10 mils ($2\frac{1}{2}$ teaspoonfuls) of a nonpurgative oil, in the morning, two hours before feeding. Administer the treatment on five consecutive mornings. The male fern should contain 24 to 25 per cent of filicine and 3.5 per cent of filicic acid.

Powdered kamala is administered as follows: To yearlings and older sheep give 15 grams divided into two doses of 7.5 grams (2 drams) each, and give at 12 to 24 hour intervals. The entire 15 grams may be given in one dose to a strong animal or divided into five doses for weak ones. After treatment sheep are dull for 3 to 5 days, they lie down a great deal, eat little or may stop eating for a day or two, and have a diarrhea. The flukes are said to die in 3 to 8 days.

It is advisable to have these drugs administered by a competent veterinarian.

Prevention.—The manure from infected sheep should not be put on pasture, especially on wet ground. Sheep should be kept off wet pasture in places where fluke is prevalent and swampy areas should be drained, filled, or fenced off. Dressings of lime and salt on pastures in June, July, and August have been recommended for killing the embryos and larvæ of the fluke and for killing and repelling snails. It is said that sheep never become infected with flukes on salt marshes. Infected sheep should be isolated and either treated for fluke or butchered before they have lost condition and become unfit for food. Where fluke is present in a flock, it is advisable to treat the flock at the beginning of winter after the danger of fresh infestation is past. Frogs, toads, and carp are useful in the control of snails. Safe drinking supplies must be provided for sheep as the infection may be water-borne.

The Oregon agricultural experiment station has recently recommended the addition of copper sulphate (bluestone) to standing water or streams in pastures to destroy the snails which are the necessary intermediate hosts of liver flukes. After ascertaining the volume of standing or running water to be treated, add one ounce of copper sulphate to 7,800 gallons of water or about one part of copper sulphate to one million parts of water. This will kill snails in 48 hours, but

will not not kill the eggs. Repeat this treatment in two or three months, after the eggs hatch. The solution is not injurious to the higher plants and animals or for bathing, drinking or irrigation, but it may injure fish.

THE LARGE LIVER FLUKE.¹⁶

Location.—The large liver fluke occurs in the liver, commonly lying in cysts which contain one to several flukes and a quantity of dark-colored fluid filled with débris. While these cysts may originate in a biliary canal, they extend into the tissue, and the fluke is habitually found as a parasite in the liver substance in cysts and not as a parasite of the canals and ducts. Wandering flukes may be found in the lungs or elsewhere.

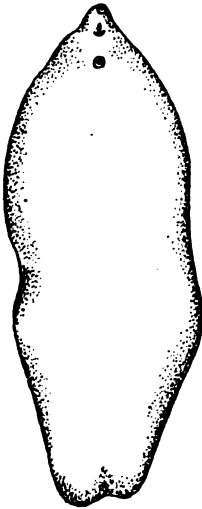


FIG. 23.—Large liver fluke (*Fascioloides magna*). Natural size. (From Stiles, 1898.)

Appearance.—This is a large, thick species, which may attain a length of 10 cm. (4 inches) (fig. 23). The anterior, or front, sucker is not carried on a distinct cone, as in the case of the common liver fluke, but in its general appearance otherwise it resembles an overgrown specimen of the common liver fluke.

Life history.—The life history of the large liver fluke has not yet been ascertained, but there is every reason to suppose that it is much the same as that of the common liver fluke, with snails of some sort, perhaps the same as those which carry the common liver fluke, as intermediary hosts.

Distribution.—North America appears to be the home of this fluke, although it has been transplanted elsewhere. In the United States it is most prevalent near the Gulf of Mexico, especially in Arkansas and along the coasts and river valleys of Texas. It also occurs along the west coast in both the United States and Canada and seems to have obtained a foothold at some inland points, as in part of Colorado. Cases are also reported from Wisconsin and New York.

Symptoms and lesions.—This parasite is much more common in cattle than in sheep. It seems to do rather little damage in cattle apart from rendering the livers unfit for use as food. In sheep, however, it may do considerable damage. Infected sheep lose condition, but the appetite persists up to the time of death. Edema is present in the form of watery swellings of the dependent portions of the body. Abortions have been reported as prevalent in a flock of infested sheep, though it is unsafe to associate this with the fluke without further evidence.

¹⁶ *Fascioloides magna*. Synonym, *Fasciola magna*.

On post-mortem examination the livers show the characteristic cysts or else dark-bluish scars where the flukes have been and where healing has taken place. The flukes apparently die in the liver instead of passing out in the spring, as the common liver fluke does. The cysts take on the character of abscesses and may be present in the lungs and spleen as well as in the liver. Affected livers and other organs contain more or less coal-black pigment characteristic of the presence of this parasite. The worms may set up peritonitis, and the omentum may show black markings.

Treatment.—No treatment is known for this disease, though the use of oleoresin of male fern or kamala is indicated as for the common liver fluke.

Prevention.—The same measures that are used in the case of the common liver fluke (see p. 35) are indicated here. As already noted, while we do not know the life history of this fluke, the probabilities are that the measures indicated will apply.

ROUNDWORMS.

The parasitic roundworms or nematodes are elongated, cylindrical, unsegmented worms. Some of them may be properly characterized as threadlike or hairlike. The body wall is usually rather transparent, and when the worms are examined with a microscope the internal organs are readily seen, usually in the form of a number of tubes. The sexes are generally separate and the males are usually smaller than the females. In general the females produce large numbers of eggs, though sometimes the eggs hatch in the body of the female and some roundworms produce embryos without the previous formation of an egg with its yolk material and shell.

Most of the roundworms of sheep reach the animal in which they develop to maturity through the direct swallowing of the eggs or young worms without passing through part of their development in some intermediate host, as the tapeworms do. In some cases the young worms that have hatched in the fields penetrate the skin of the host animal, entering the body in this way instead of by the mouth. Other worms have an intermediate host and undergo a certain development in this host before getting to the final host. The intermediate host harboring the larval worms may be eaten by the final host, thus infecting it through the digestive tract, or such intermediate hosts as mosquitoes may infect the final host by inoculating it with the larval worms which then penetrate the skin.

Even in the case of direct infection, when eggs or young worms are swallowed by the host animal, nematodes which develop to maturity in the intestine may not go directly there and develop immediately. They may pass through the walls of the digestive

tract and get to the blood stream, leave the blood stream for the air passages of the lungs, crawl up the windpipe, and then pass down the esophagus or gullet, and thus reach the intestine again, where they continue their development to maturity.

THE STOMACH WORM.¹⁷

Location.—This worm is a parasite of the fourth stomach. It may be found elsewhere in the digestive tract, but such occurrences are of little significance.

Appearance.—Stomach worms (fig. 24) are from one-half to 1½ inches long and about as thick as an ordinary pin. The females are the larger and have a spiral striping. In the rear half of the body of the female there is a projecting portion, which may be seen on close examination. The smaller male may be distinguished by the

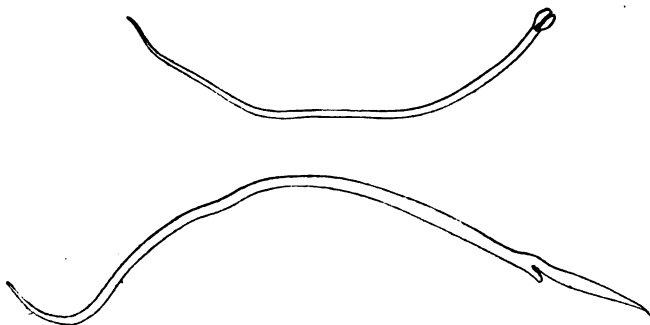


FIG. 24.—Stomach worms (*Haemonchus contortus*). Upper figure, male; lower, female. Magnified five times.

fact that the posterior or tail end of the body is flattened and expanded.

Life history.—The eggs produced by the female worms pass out in the manure and hatch in a few hours under the most favorable conditions of warmth and moisture. Under less favorable conditions hatching may require a number of days or even weeks. The embryo which leaves the egg undergoes further development until it becomes an ensheathed, infective larva. In this condition it is inclosed in a double skin and is very resistant. Whereas drying and low temperatures may kill the egg or embryo previous to this stage, the ensheathed larva can withstand severe cold and long periods of dryness. When the grass is wet with rain or dew, these larvæ crawl up the blades. Here they are swallowed by sheep as they graze. In the stomach the worms become mature in the course of two to three

¹⁷ *Haemonchus contortus*. For additional information see Department Circular 47 on "Stomach Worms in Sheep."

weeks, but do not begin to produce eggs in large numbers until about a month after they are taken in by the sheep.

Distribution.—The stomach worm occurs over almost the entire world, wherever there are sheep, cattle, or other suitable host animals. In the United States it is most plentiful in the South, where it is favored by abundance of warmth and moisture, but it is quite a common and serious pest in the Middle West and in low, wet areas throughout the entire country. It is present in smaller numbers and does less damage in the high, dry, and cool areas of the Rocky Mountain States.

Symptoms and lesions.—The first things noticed about infested sheep are dullness and lack of thrift. Diarrhea may be present. Later, the more characteristic features of stomach-worm disease become evident in the form of anemia and edema. The anemia is manifested in the paleness of the skin and of the linings of the mouth and eyelids, and is due to the impoverishment of the blood from the bloodsucking habit of the worms. The edema is manifested in a swelling of the pendant portions of the body, especially of the portion under the jaw, causing what is called "bottle jaw." Sheep may become emaciated and finally die.

If the fourth stomach of a sheep infested with stomach worms is opened (the fourth stomach is the one to which the upper end of the small intestine attaches), the worms can usually be seen as wriggling red objects. When the contents of the stomach are poured out many of the worms will usually remain attached to the lining of the stomach. A little careful washing will reveal the worms if they are covered by the stomach contents. Close investigation of the lining of the fourth stomach will also reveal the pin-point punctures caused by the bites of the worms. There are usually a number of these for every worm, as the worm has the habit of attaching at one point for a time and then moving away and attaching at another point, leaving the old point of attachment bleeding for some time. The carcass of a sheep seriously infested with stomach worms is liable to be emaciated and the meat pale.

Treatment.—A satisfactory treatment for this disease is the use of a 1 per cent solution of copper sulphate in water. A dose which has been found satisfactory is 100 mils (about 3 ounces) for yearlings and older sheep and half as much for lambs 3 months old or older. To make this solution, dissolve one-fourth pound of copper sulphate in 1 pint of boiling water, then add cold water to make a total of 3 gallons of the solution. Porcelain or enamel-ware receptacles should be used for the solution, as bluestone (copper sulphate) will corrode metal. This amount will dose 100 adult sheep, allowing 10 per cent waste. Use only clear blue crystals of copper sulphate,

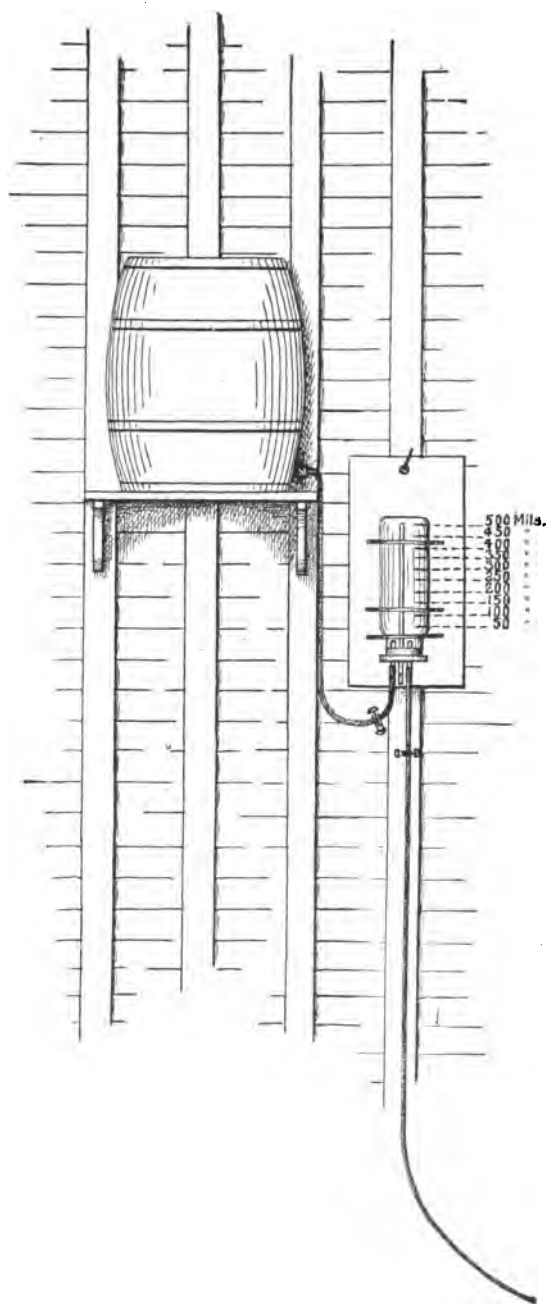


FIG. 25.—Dosing device for administering copper-sulphate solution.

discarding the pieces that have turned white. Crushing the crystals will hasten solution. In dosing, one may use a rubber tube with a funnel on one end and a piece of metal tube at the other. The metal tube is placed in the sheep's mouth and the solution slowly poured through the funnel. If large numbers of sheep are to be treated, the apparatus figured (fig. 25), or something similar to it, may be used. The copper-sulphate solution is fed from a high reservoir, by siphoning or by a tube or spigot near the bottom, through a rubber tube into an open graduated glass tube, which may be made from a large olive jar, and allowed to escape in measured doses through the other rubber tube to the metal tube in the sheep's mouth. Instead of an open graduated glass tube, a large bottle or jar may be used if a third tube is put in the jar, through the cork, one end being open to the outside and the

other opening near the bottom of the inverted jar, to equalize air pressure. This is shown in figure 25. The flow into and out of the glass tube is controlled by pinchcocks, one person attending to this and one holding the metal tube in the sheep's mouth. The sheep should remain on all four legs, with the head held horizontally while it is being drenched, which decreases the danger of getting the drench into the lungs and killing the sheep. The solution should be allowed to flow slowly and the metal tube be moved about slightly in the mouth at the same time in order to keep the sheep swallowing. It is essential that the copper-sulphate solution be made up accurately, be given in suitable doses, and be administered with care, and it is advisable to have a competent veterinarian give this treatment or the ones noted below in order to insure a maximum degree of safety.

The sodium-arsenite and copper-sulphate mixture and the copper-sulphate and tobacco solution, recommended for tapeworm, have also been recommended as effective against stomach worm (p. 22).

Prevention.—Preventive measures are based on the life history. We know that the disease is spread by eggs produced by the female worm, which escape in the manure on to the pastures. Infested sheep must be regarded as a danger to young and uninfested sheep. The manure from the infested sheep is likewise dangerous. Consequently, young animals and uninfested sheep should be separated from older or infested animals and not exposed to contact with the manure from these animals. Furthermore, pastures which have been used by infested animals are dangerous to young animals and uninfested ones. When animals that have stomach worms, either in a light or heavy infestation, are put on clean pasture, the eggs of the stomach worm will hatch on the ground and the infective stage of the worm will be present on the grass in considerable numbers in from 10 to 20 days, or even earlier in warm weather. The longer the sheep are on that pasture under ordinary weather conditions the more dangerous it will become from the increasing number of worms. To prevent getting dangerous infestations, it is advisable that sheep be moved every two weeks to clean pasture. Inasmuch as pastures probably remain infected for about a year after sheep, goats, or cattle are moved from them, the program of moving sheep to new pasture, where permanent pastures are used, is a rather difficult one and calls for more land than is usually available. Consequently a modification of this program is necessary.

The first essential is to protect the lambs. Young animals are more susceptible to parasitic infestation than older ones. They also suffer more from parasites when they are infected. Growth must be made during youth; it can not be made up in mature years. Parasites interfere seriously with growth and lead to the production of runts. Consequently the safest pasture should be furnished to the lambs,

the older sheep taking the more dangerous pasture, where it is necessary for sheep to go back to old pasture within a year. It may be mentioned in passing that hillside pastures are apt to be safer than bottom land, as they benefit by the cleansing action of heavy rains and the following run-off, as well as holding less moisture, lack of moisture being very unfavorable to the worms. Rich bottom pastures, on the other hand, are the ones which are least likely to have an infection washed off and are apt to have the eggs and larvæ from the hillsides above washed on to them. The more or less abundant moisture, moreover, is highly favorable to these worms. It is precisely these bottom pastures which are likely to be used for young animals, as they present the best growth of grass and are most attractive.

In a plan of rotating pastures to keep down stomach worms, the sheep may be moved over cornfields, hayfields, and stubble of various sorts. During freezing weather, the eggs and nonresistant early stages of the young worms on pasture diminish as they are killed by freezing, so that the pastures at this time, while still infected, do not become increasingly dangerous. Plowing is a means by which infestation may be controlled, the young worms being turned under and buried; apparently they do not get back to the surface in numbers sufficient to cause serious trouble. Such plowed land may be sown to forage crops and the sheep turned in on these crops with safety. When different kinds of stock are rotated on pastures, sheep may safely follow horses or swine, but not cattle or goats as these latter also may be infected with stomach worms and a number of other worms common to sheep, goats, and cattle.

If the preventive measures outlined here are not possible, sheep may be given the copper-sulphate treatment, preferably in doses three-fourths as large as those where one treatment is given, once every six weeks from spring until freezing weather.

THE NODULAR WORM.¹⁸

Location.—The adults of the nodular worm live in the large intestine of the sheep. The larval worms live in nodules in the wall of the large and small intestine, and occasionally make their way to the mesenteric lymph glands, the omentum, or the liver. The nodules are most numerous in the wall of the large intestine.

Appearance.—The female worms attain a length of 15 mm. (about five-eighths inch), the males being a little shorter (fig. 26). Both sexes have a characteristic solid white color. The head is bent over and forms a hook with the body.

Life history.—The details of the life history of this worm are not completely known. The eggs from the female in the large intestine

¹⁸ *Proteracrum columbianum*. Synonym, *Esophagostomum columbianum*.

of the sheep are passed in the manure. The subsequent development of the worm up to the time it is again found in the sheep has not been determined. When the young worms are first found in the sheep they are encysted in the wall of the intestine. These cysts commonly reach a considerable size and contain a necrotic material, usually yellowish or greenish in color, cheesy in consistence or often hard and almost stonelike (fig. 27). After a time the larvæ leave these nodules and become adults in the lumen of the large intestine. Usually larvæ can be found only in the smaller and more recent nodules. Those larvæ which get to the mesenteric lymph glands, the omentum, and the liver probably die in these places and never get back to the intestine to complete their development.

Distribution.—This parasite was originally present in this country only in the Southern and Eastern States, but it has been spreading westward, probably with infested sheep introduced into western localities for breeding purposes, and there is reason to fear that it will become generally distributed over the country. It has become rather common in the Middle West, and is a serious pest in the Northeastern States. It is still uncommon in the Rocky Mountain States, and as yet has not been reported from a number of these States.

Symptoms and lesions.—According to one investigator (Curtice) the symptoms of this disease may be only those of general debility—a pale mucous lining of the eyelids and mouth, emaciation, dry wool, etc. In severe cases diarrhea and emaciation may be excessive. In some places sheep raising has been abandoned on account of the damage done by this worm. It is evident that the injury due to numerous intestinal nodules, which prevent large areas of the intestine from functioning properly in the work of secretion and absorption, which act as persistent irritants to the sensitive nervous system of the digestive tract, and which serve to supply poisonous material from worms, bacteria, and dead tissue to the adjacent absorbing tissues of the intestines, can not fail to have a bad effect on the host animal. The resultant loss can not be accurately stated, but it occurs in terms of meat, wool, decreased growth, and poorer quality of animals and from the fact that nodular intestines, or so-called “knotty guts,” are unfit for sausage casings.

The post-mortem lesions are easily seen, the principal ones being the nodules, which may be larger than a good-sized pea, on the walls of the large and small intestines, or in the mesenteric lymph glands,

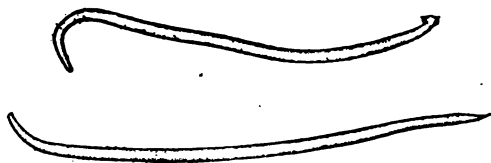


FIG. 26.—Nodular worm (*Proteracrum columbianum*). Upper figure, male; lower, female. Magnified five times.

the omentum, or the liver. The nodules may be small, elevated objects, or may be larger and contain cheesy or limy matter, white, greenish, or yellowish in color. These nodules are sometimes mistaken for lesions of tuberculosis, a disease almost unknown in sheep.

Treatment.—As yet we have no satisfactory treatment for this disease. The larval worms in the nodules are beyond the reach of any remedies as yet known to us. Even the adult worms in the large intestine are difficult to remove. There is some difficulty in getting a suitable drug past the four stomachs of a ruminant and into the large amount of food matter in the large intestine in sufficient strength to remove these worms. Experiments in the Bureau of Animal Industry have indicated that gasoline, in doses up to an ounce, given in milk, may remove some of the worms, but in half-



FIG. 27.—Sheep intestines showing lesions of nodular worm disease.

ounce doses may fail to remove any. Gasoline is a rather dangerous substance owing to its inflammability and the danger of getting it into the lungs and killing the sheep, and the efficacy noted is so low as hardly to warrant its use.

Prevention.—Pasture rotation, as given in the case of the stomach worm, is a valuable control measure. Dalrymple found that he could practically prevent the nodular-worm infection of lambs by raising them in bare lots, where there would be no temptation to graze and where surroundings would be unfavorable for the development of the parasite. The ewes were let into these lots whenever necessary to nurse the lambs. The lambs were given other feed from raised racks and watered from raised troughs. The racks and troughs were protected from fecal contamination and the floor of the yard

cleaned frequently to keep it free from litter and manure, thereby preventing the development of the eggs in the manure in the yards. As in most parasitic diseases, the young animals suffer more than older ones and measures must be directed especially to the protection of the lambs. If persisted in, these measures and pasture rotation should keep the infestation down to a point where it does little damage.

THE SHEEP HOOKWORM.¹⁹

Location.—Hookworms of sheep are found in the small intestine.

Appearance.—The female hookworm attains a length of 2.6 cm. (about 1 inch), the male attaining a maximum length of 1.7 cm. (fig. 28). The worms are about one-half to three-fourths as thick as an ordinary pin. At the head end is a mouth capsule armed with teeth. The tail end of the male is expanded and flattened.

Life history.—The life history of the sheep hookworm has received little attention, but, judging from the life history of related forms, it is probably about as follows: The eggs produced by the female worm in the intestine of the sheep pass out in the manure and hatch on the pasture. Under favorable conditions of temperature and moisture the

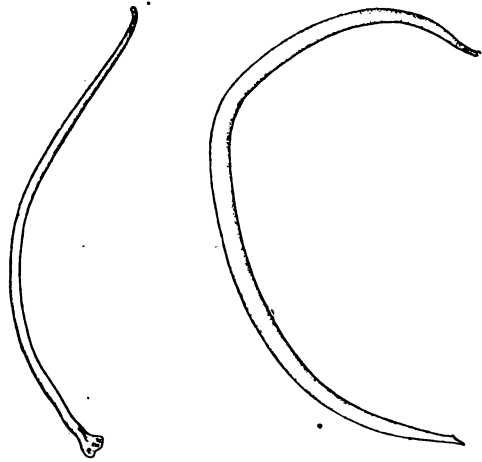


FIG. 28.—Sheep hookworm (*Bunostomum trigonocephalum*). Female at right; male at left. Magnified. (From Ransom, 1911.)

young worms develop to a resistant form capable of infecting sheep. Possibly most of the infection takes place by way of the skin, the larval worms boring through the skin of the lower part of the legs and making their way to the near-by blood vessels. In the blood the worms would be carried to the lungs, where they would escape from the blood and get into the air passages. Here they would make their way up the windpipe and then down the gullet into the stomach and intestine. When they reach the intestine they develop to adult worms and the two sexes mate. In addition to the possible entrance of larvæ through the skin, many of the infective larvæ on the pasture are undoubtedly swallowed by the sheep in food or water, but even in this case it is possible that the larvæ make their way to the blood stream

¹⁹ *Bunostomum trigonocephalum*. Synonym, *Monodontus trigonocephalus*.

from the digestive tract and return by way of the lungs again before developing to maturity.

Distribution.—This parasite is common in sheep in the Southern States and has been found as far north as New York. Additional studies in various localities would doubtless show a wider distribution. It is apparently fairly common in Europe.

Symptoms and lesions.—The symptoms resulting from infestation with the sheep hookworm have not received much attention, but its habits are similar to those of the hookworm in man and in the dog, and these are known to cause very serious damage, so that there can be little question as to the damage that hookworm may do in sheep. The worms are bloodsuckers, with the habit of attaching for some time at one place and then moving to another, leaving the first puncture still bleeding. This bleeding persists for some time, as the result of a secretion from the mouth parts of the worm which has the power to dissolve the blood corpuscles and prevent clotting.

With hookworms in general it is not uncommon to see 10 or 12 hemorrhages associated with a single worm. This loss of blood results in its impoverishment, as well as in a net loss in amount of blood present. This in turn causes a seepage of the thinned blood out of the blood vessels and into the tissues, causing watery swellings, or edema, of the pendant portions of the body, as well as an associated condition, or dropsy, within the body. With the impoverishment of the blood the nutrition of the animal is impaired—a very serious matter with young animals. We may safely infer that there is serious damage to the sheep's nervous system, preventing its smooth functioning and making for poor animals and poor offspring.

The things that may be looked for in connection with hookworm disease are paleness of the mucous lining of the eyelids and mouth, pale skin, dry wool, watery swellings under the jaw and along the abdomen, and a general condition of unthriftiness. The condition is very similar to that found in stomach-worm disease, as the two worms affect the host animal in substantially the same way. As it is usually complicated with stomach-worm disease, hookworm infestation is not apt to be recognized as a distinct disease. The only way to make a satisfactory diagnosis between the two conditions is by a post-mortem examination of the fourth stomach and the small intestine in order to ascertain which of the worms is present. In some cases both species of worms will be found and the results may be attributed to the mixed infestation. The lesions caused by the hookworm are red spots, or small hemorrhages, in the small intestine, while similar spots in the fourth stomach are caused by stomach worms.

Treatment.—Oil of chenopodium (American wormseed oil) in doses of about 1 dram (1 teaspoonful) in about 5 ounces of milk

has been found experimentally to remove about two-thirds of the hookworms present, and petroleum benzine (a high-grade gasoline) has been found to remove about three-fourths of the worms when given in doses of a half-ounce in milk. In view of the greater safety in the use of chenopodium, this remedy seems preferable. A second treatment may be given after a lapse of two weeks. The copper-sulphate and tobacco solution recommended for tapeworms has also been recommended for hookworms.

Prevention.—Pasture-rotation methods, as outlined under the subject of stomach worms, will be found of great value in controlling sheep hookworms. Proper disposal of the manure, which carries the eggs of the worm, is also important. In view of the fact that this worm possibly enters the sheep through

the skin of the legs as well as through the mouth while the animal is grazing, boggy land and loose, wet, sandy soil may be looked on with suspicion as apt to convey the infection by bringing the larvæ in contact with the skin in mud or wet sand.

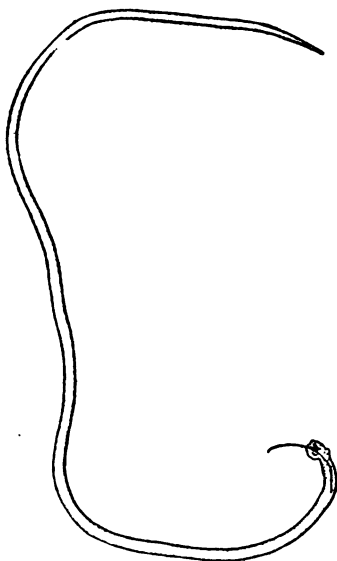


FIG. 29.—Thread-necked strongyle (*Nematodirus spathiger*). Male, greatly magnified. (From Ransom, 1911.)

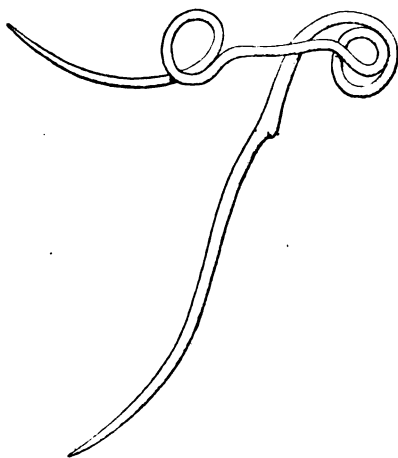


FIG. 30.—Thread-necked strongyle (*Nematodirus spathiger*). Female, greatly magnified. (From Ransom, 1911.)

THE THREAD-NECKED STRONGYLES.²⁰

Location.—The thread-necked strongyles are found in the small intestine.

Appearance.—These are slender worms, the anterior portion more slender than the posterior. The head and the neck end are transversely striated. In *N. spathiger* the male worm attains a length of 1.5 cm. ($\frac{3}{8}$ inch). The female

attains a length of 2.3 cm. (about 1 inch).

Life history.—The eggs produced by the female worm pass out in the feces and an embryo develops in them. This worm molts twice in

²⁰ *Nematodirus filicollis*, *N. spathiger*, etc.

the shell, the skin that separates at the second molt, however, remaining on the larva. The larva hatches under the influence of alternate moistening and drying or of temperatures of 24° to 32° C. (75° to 90° F.). Like the stomach worm, the ensheathed larva then ascends blades of grass under favorable conditions of temperature and moisture, and is taken in by sheep as they feed. These larvæ are very resistant to cold and drying, and have also been found to live in water for over 11 months. In the intestine of the sheep the larvæ develop to adult worms.

Distribution.—At least one species of these worms (*N. spathiger*) appears to be quite common in sheep in the United States.

Symptoms and lesions.—When present in small numbers it is unlikely that these worms do much damage, but sheep infested with large numbers have been found to be unthrifty. So far the only symptoms that may be attributed to them are those commonly associated with gastrointestinal parasitism in general—those of malnutrition. No definite lesions have yet been described for this worm.

Treatment.—The treatment for infestation with this worm has not yet been worked out. Oil of chenopodium, as given for hookworm, is worth trying. As previously noted, the removal of these worms may prove difficult.

Prevention.—The same measures that are of value against stomach worms will probably be of value against the thread-necked worms.

THE WHIPWORM.²¹

Location.—The whipworm occurs in the large intestine, usually in the cecum, but rarely elsewhere in the digestive tract.

Appearance.—The body of this worm is thick posteriorly and very slender anteriorly, the anterior portion of the body being two or three times as long as the posterior portion, from which fact it receives the name of whipworm. The thick portion is comparable to a whip handle and the thin portion to a whiplash (fig. 31). The male is 5 to 8 cm. (2 inches to over 3 inches) long, with the anterior portion of the body three times as long as the posterior portion. The male spicule is 5 to 6 mm. long, and has a long sheath, covered with spines, and terminating in a bulbous enlargement. The female is 5 to 7 cm. long, with the anterior portion of the body twice as long as the posterior portion. The eggs of the whipworms are characteristically lemon-shaped.

Life history.—So far as is known this worm has a simple life history. The eggs produced by the adult worm pass out in the feces

²¹ *Trichuris ovis*.

and an embryo develops in each egg under suitable conditions of temperature and moisture. When these eggs are swallowed by sheep, the embryos develop to adult worms.

Distribution.—These worms are very common in sheep in the United States and many other countries.

Symptoms and lesions.—It has been found that whipworms in man set up a low-grade inflammation, with distinct symptoms of discomfort and distress. In animals, inflamed areas are quite commonly found where whipworms attach. The head end of the worm is usually found sewed into the mucosa, and, as the mouth is unarmed, it appears that the penetration of the mucosa is perhaps due to the digestive action of a substance secreted by the worm. There is likelihood of the lining of the intestine being infected by bacteria through the entrance of the worm, or of the burrow becoming infected subsequently. Though there are no well-defined clinical symptoms for whipworm infestation in sheep, it can not be doubted that the worms exert an injurious effect, more pronounced when the worms are numerous. On post-mortem examination the thick posterior ends of the worms will be found in the lumen of the intestine, the anterior ends being in the mucosa.

Treatment.—There is no satisfactory treatment yet known to us for whipworm in sheep.

Prevention.—Prevention of whipworm in sheep is a matter of sanitation and pasture rotation. The same measures that are useful in controlling stomach worm will be found of value in controlling whipworm.

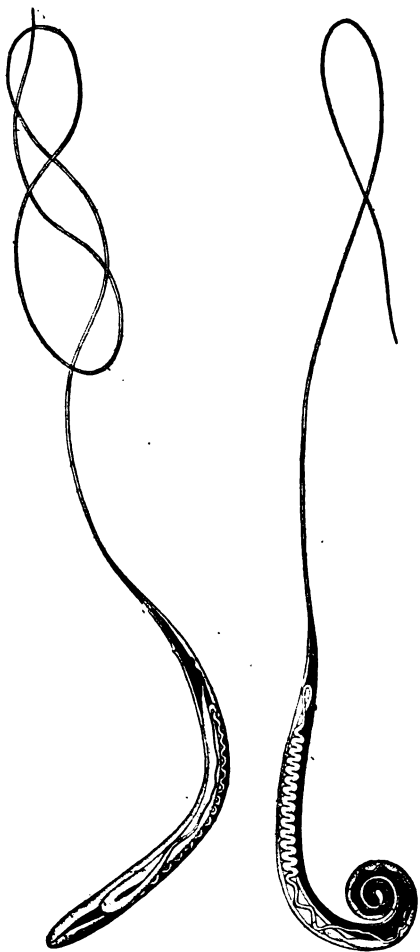


FIG. 31.—Whipworms (*Trichuris ovis*). Female at left; male at right. Magnified. (From Curtice, 1890.)

THE THREAD LUNGWORM.²²

Location.—The thread lungworm is found in the air passages, bronchi and bronchioles of the lungs.

Appearance.—These are rather long worms, easily observed. They are white and the intestine shows as a dark hair line throughout the length of the worm (fig. 32). The male is 3 to 8 cm. (from more than 1 inch to more than 3 inches) long. The female is 5 to 10 cm. (2 to 4 inches) long, with a straight, conical tail. The eggs contain an embryo when they leave the body of the mother worm.

Life history.—The eggs deposited by the female hatch in the lung of the host animal, probably in the course of 24 hours, and are expelled in coughing, or swallowed and passed in the feces. The newly hatched larva has a rounded head and a rather blunt tail. It molts twice in the course of the next few days, the time varying with temperature and moisture, and, under ordinary circumstances, is infective within 10 days. This larva then climbs up grass blades, when they are wet and the weather is warm, as does the larva of the stomach worm and thread-necked worm, and here it is taken in by grazing sheep and makes its way to the lungs. In the course of a month the sheep begin to show symptoms of lungworm, and in about five weeks embryos appear in the manure.

Distribution.—These worms are widely distributed over the world and are comparatively common in the United States, especially in the South and where there is plenty of moisture and warmth.

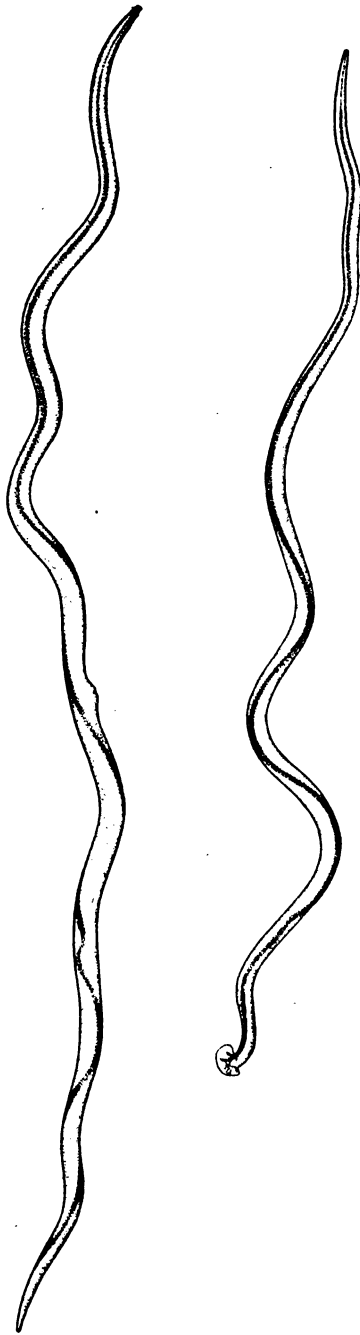


FIG. 32.—Thread lungworms (*Dictyocaulus flaria*). Male at right; female at left. Highly magnified. (From Curtice, 1890.)

²² *Dictyocaulus flaria*. Synonym, *Strongylus flaria*. Google

Symptoms and lesions.—The worms and their eggs and larvæ set up an irritation of the lung tissue at the point where they are located, causing inflammation and a catarrhal condition, the latter manifested in the production of a frothy mucus, sometimes containing traces of blood. Bacterial infection of the weakened lung tissue may follow, and the lungs may show pus and consolidated areas. Usually the latter conditions are not present. The symptom first noted is a husky cough, and if the invasion is extensive this may be followed by difficulty in breathing. If left alone some animals are likely to die of weakness or suffocation. The disease may be diagnosed from the clinical symptoms by an experienced veterinarian or stockman who is familiar with it; the diagnosis may be confirmed by a microscopic examination of the saliva from the back of the tongue or from the pharynx, though occasionally one may not find larvæ, especially in recent infections, in spite of the presence of worms in the lungs. On post-mortem the lungs show inflamed patches, and the worms can be found in the air passages.

Treatment.—Most of the treatments by intratracheal injections that have been used for lungworm disease of cattle are not very satisfactory and are rather dangerous to sheep. A treatment which has been used on a large number of animals with reports of satisfactory results consists in injecting chloroform in 3-mil doses (about three-fourths of a teaspoonful) into the nostrils of the sheep by means of a medicine dropper, the head of the sheep being tilted back. The nostrils of the sheep are then held with the fingers until the animal is somewhat groggy. This treatment may be repeated at intervals of three to five days, if necessary, for a total of not more than three doses. It is recommended that a dose of Epsom or Glauber's salt be given two hours after the treatment.

Nursing treatment is always advisable in this disease. Sheep should be taken off wet pasture and placed on high, dry pasture or put up and fed dry feed. A safe supply of drinking water and plenty of good feed are of value in tiding the sheep over the critical stages of the disease and allowing the worms to die out.

Prevention.—The same general rules that apply in the case of the stomach worm apply here. Sanitation and pasture rotation, isolation of infested animals, and special precautions in regard to the pasturing and watering of lambs and young animals are all measures of value.

THE HAIR LUNGWORM.²³

Location.—These worms occur in the small bronchioles and in the lung tissue.

²³ *Synthesetocaulus rufescens*. Synonym, *Strongylus rufescens*.

Appearance.—Hair lungworms (figs. 33 and 34) are much smaller than the thread lungworms. The body has a characteristic brownish-red color, due to the color of the intestine. The male is 1.8 to 2.8 cm. (about two-thirds inch to a little more than 1 inch) long and terminates at the tail in a corneus arc, followed by the small bursa (fig.

33). The female is 2.5 to 3.5 cm. (1 to 1.4 inches) long, with a moderately pointed tail.

Life history.—The life history of the hair lungworm has not yet been worked out, but it is probably similar to that of the thread lungworm.

Distribution.—The parasite is widely distributed and has been found to be fairly common in the United States. It is perhaps less common than the previous species or is possibly found less often because it is smaller.

Symptoms and lesions.—These worms occasion various forms of verminous

pneumonia. The adult worms cause a lobular pneumonia; the eggs and larvæ cause a diffuse pneumonia, or when aggregated in the pneumonic areas may cause a pneumonia with areas resembling tubercles. These areas show as grayish-yellow tumors, which may attain a diameter ranging from a few millimeters to 2 centimeters (four-fifths of an inch). Careful post-mortem examination of these pneumonic areas will disclose the reddish worms, and the eggs and embryos may be found by microscopic examination of such tissue. The weakened tissues afford lodging for disease-producing bacteria, sometimes leading to pus formation, in which case the evil effects are considerably increased. Sheep will survive an infection with worms which prevents only a small amount of lung tissue from functioning, but heavy infections reduce the amount of living tissue available for breathing to an extent that often proves fatal, and bacterial complications add to this and to the toxic material which is absorbed to the injury of the animal.



FIG. 33.—Hair lungworm (*Synthetocaulus rufescens*). Tail of male, viewed from side. (From Railliet, 1893.)



FIG. 34.—Hair lungworm (*Synthetocaulus rufescens*). Tail of female, viewed from side. (From Curtice, 1890.)

Treatment.—We have little evidence in regard to a satisfactory treatment for this worm, but the treatment, including nursing treatment, given for the preceding species would be worth trying.

Prevention.—The preventive measures outlined for the thread lungworm apply here.

OTHER INTERNAL PARASITES.

Various other kinds of roundworms besides those that have been mentioned infest sheep, and some of them at times prove very injurious. The methods of prevention recommended for stomach worms, hookworms, and others in this bulletin, will help to protect sheep also from these other roundworms. There are also certain species of flukes, tapeworms, protozoa, and arthropods, other than those discussed here, which are omitted because they are relatively less important, so far as we are aware at present.

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Stomach Worms in Sheep. (Department Circular 47.)

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